Attilio Sacripanti

Kumi Kata

From Dojo to High Level Competition.

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Courtesy of IJF President

Attilio Sacripanti

Kumi Kata Biomechanics and a survey of related researches

Forewords, by Nicola Tempesta VIII° Dan First Italian European Champion 1957, 1961.

Forewords, by Envic Galea, President of the Malta Judo Federation, EJU General Secretary.

Forewords, by Densign Withe, President of the British Judo Federation, Chairman of EJU Men Coaches Commission.

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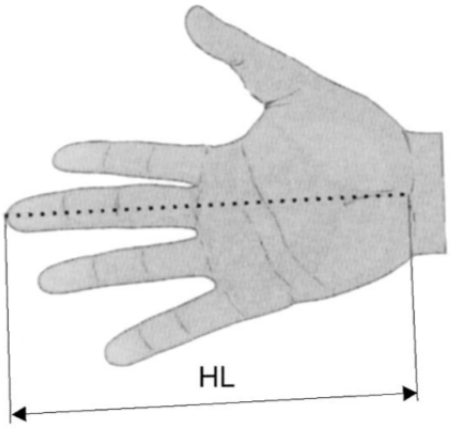
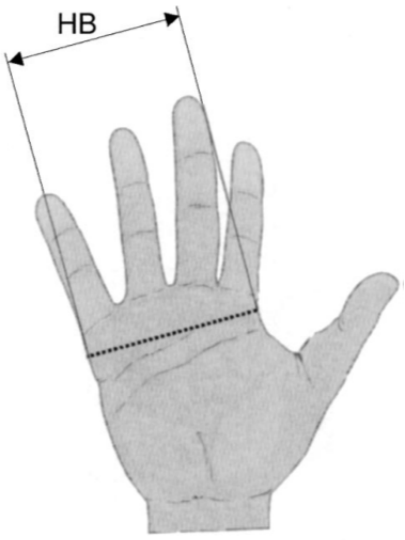
Kumi Kata Biomechanics

And

A survey of related researches





Foreword

By Nicola Tempesta VIII° Dan
European Champion 1957, 1961

I accepted with great pleasure the invitation to write a forward to Attilio Sacripanti's book on Kumi Kata. However after reading the book, my pleasure changed to admiration for the deep analysis you will find in this book. I lived both the start of Italian judo and the birth of European Judo with my opponent and friend Anton Geesink, now I understand that Judo in old time depended on Kodokan Judo rules.

During that time you could only see only one grip on the European mats, the "Ki Hon Kumi Kata" with little different styles. All throws were, essentially, the throwing techniques explained in the Kodokan Go Kyo. Contests were 20 minutes long, and in case of draw, competitions were extended until there was a winner. The mat was raised and going out of the competition area was impossible.

Kumi Kata was considered like a "steering- wheel", a tool to drive our opponent in the right position to apply personal Tokuy Waza (one or two) with connected effective renraku and Renzoku. Our aim was to find an Ippon, with more moving tactics, than by grip fighting strategies like it is usual today. We did not fear to grip and to be gripped, it was the best technique that prevailed, applied by means a strong entry as a train that crashed into a car, as my friend Okano used to remind us.

In my time as National Coach, as judo changed in style, I too had to come to face the effectiveness of fighting with grips. I studied for a long time with my students, how to control our opponents with different grips. During the two training stage held in Sperlonga 1967-1968, with my friend Cesare Barioli, Sensei Tadashi Koike and thirty more Masters , we laid the foundation of Italian Judo revival introducing, among other, the first information on grips and using grips effectively in competition.

But Kumi Kata is still connected to the "steering wheel "idea in my mind, why? Because still today during competitions it is important to take the initiative and drive the competition like a leading actor and not like a follower, with a continuous attack till you find an opening into the opponent's defense to give us the victory, preferably by Ippon.

I wish a great success to this book of my friend Attilio. He guides us not only in the Kumi Kata good practice-teaching at club or at national level, but also in every fine point useful in high-level competition.

In this textbook, athletes, coaches and teachers will find a useful tool to increase knowledge and experiences on Kumi Kata and High-level competition, with a clear scientific explanation in the matter.

M° Nicola Tempesta. VIII° Dan

First Italian, European Champion (1957, 1961) 6 times second and one time third.

Technical Director of the Italian National team, from the 1968 to 1976.

Napoli April 25 , 2011

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4/23/2011

Foreword
By Envic Galea
President of Malta Judo Federation

I have known Attilio as a Judoka, referee and a friend for many years, having met at one of the refresher courses for refereeing in Italy. Attilio, today is an authority in Sport Biomechanics and we are lucky that he specialised in his favourite sport, Judo.

His researches, contributed to produce some of the most detailed scientific books in biomechanics. This book Biomechanics in Kumikata, is his last contribution to his analytical expertise to grips in Judo, will be a great tool to our researchers and coaches and Judoka all over the world, in their continued search for a better judo.

Envic Galea
President Malta Judo Federation
General Secretary European Judo Union

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Foreword

By Densign Withe VII° Dan
Chairman of British Judo Association
EJU Sport Director

The mastery of Kumi Kata is a critical component for any judoka who aspires to succeed in the modern judo era. Without this skill being very well developed and understood in the deepest sense it is difficult to see how any judoka can experience the thrill and the most exciting part of judo which is the ability to throw ones opponent cleanly, effortlessly and with grace and beauty.

It is also important that the people who are responsible for coaching Judo have the knowledge of good kumi kata, especially for those that work with young children as we all know that once bad habits set in as a result of poor instruction from the beginning, it can be very difficult to correct errors a few years on.

That is why Mr Sacripanti's book will provide a necessary resource tool that every coach can use as a great educational reference point.

Everyone in judo recognizes that our sport is incredibly technical and so it is surprising to me that there are so few resources available that provide detailed analysis of judo techniques in a sport science context.

We are indeed fortunate in the Judo world that Attilio Sacripanti a judoka and a scholar have decided to write this important and unique book.

It comes at a time when there is a thirst for knowledge among the Judo coach community and when sports science is becoming the cutting edge difference between those athletes that stand on the podium and those who do not.

There is limited sport science research that relates to judo specifically and so this book will be a must have treasured item for every serious Judoka in whatever capacity they are involved in our sport.

Densign White

Chairman British Judo Association

EJU Head Sports director

3 x Olympian

London 5/18/2011

Biomechanics and a survey of related researches

1 Introduction

Kumi Kata is an essential part of Judo fight, but very few scientific approaches to this problem are born in this field. The definition of Kumi Kata is grip fighting. The word “grip fighting” means to take a grip that will provide you with advantage over your opponent, but also to not let your opponent take is comfortable grip in order to be able to counter.
The reason a fighter needs to take his grip of his opponent is because without the grip he cannot throw. He cannot perform any effective attack without a grip.
But grips are not only hands and arms but also trunk, legs and feet.
This means that grips are a whole body concept and not only an upper kinetic chains dominium.
A good grip will assist in blocking attacks, but most important, will assist in enabling you to attack!
Goal of this work is to clarify some not well defined problems about grips, to in deep the knowledge about fighting grips, evaluating both advantage and disadvantage of some empirical information applied, and to find some new way to apply proper grips and connected throws in competition based on a correct biomechanical approach, not discharging to enlarge the basic teaching methodologies.

2 Basic Biomechanics of Grip

2.1 Muscles Involved In Power Grip Strength

There are 35 muscles involved in movement of the forearm and hand, with many of these involved in gripping activities. During gripping activities, “the muscles of the flexor mechanism in the hand and forearm create grip strength while the extensors of the forearm stabilize the wrist”. There are four major joints of the hand, Carpo-metacarpal, Inter-metacarpal, Metacarpo-phalangeal, and inter-phalangeal joint, with “9 extrinsic muscles that cross the wrist and 10 intrinsic muscles with both of their attachments distal to the wrist ” These muscles include the pronator radii teres, flexor carpi radialis, flexor carpi ulanris, flexor sublimis digitorum, and Palmaris longus on the extrinsic layer and the flexor profundus digitorum, flexor policus longus, pronator quadratus, flexor pollicus brevis, and abductor pollicus brevis on the intrinsic layer. Each of these muscles is active during gripping activities.
According to German Sports Scientist Jurgen Weinick, “the characteristic structure of the hand is related to its function as a grasping tool. Grasping ability is made possible by the fact that the thumb can be opposed to the fingers. The fingers and the thumb act as a versatile pair of pliers. They need the palm of the hand as a flat base, on which the object grasped can be held.” From this statement, it can be concluded that the anatomy of the hand is more geared toward flexion than extension.

2.2 Grip Musculature

You ever shake someone’s hand that had world class grip strength. You know they are strong. Grip strength is a limiting factor in many strength based activities as the load that the low back extensors or legs can maintain may be far greater than the load potential of the forearm flexor musculature. The forearms contain 23 different muscles, “”of flexors and “” of extensors.
Each of these plays a critical role in sports as

Forearm Flexors

1. Flexor Digitorum Superficialis
2. Flexor Digitorum Profundus (4 heads)
3. Palmaris Longus
4. Flexor Pollicis Longus
5. Flexor Carpi Ulnaris
6. Flexor Carpi Radialis

Forearm Extensors

1. ExtensorDigitorum
2. Extensor Pollicis Brevis
3. Entensor Pollicis Longus
4. Extensor Carpi Radialis Longus
5. Extensor Carpi Radialis Brevis
6. Extensor Carpi Ulnaris
7. Extensor Digiti Minimi
8. Extensor Indicis

Brachioradialis

2.3 Cylindrical Grip in Judo

Fig.1 The Three Types of Power Grips: and judo examples

From the previous figure we understand that in judo Cylindrical power grip (a) is the most common. Round power grip (b) is applied by Russian style on the back, or during Sode Tsuri Throws,, And Lifting power grip (c) is applied during the obi grip.
A recent study on the torque and grip forces on male and female cylindrical power grip, has shown that maximum grip forces is applied with minimum cylinder diameter.

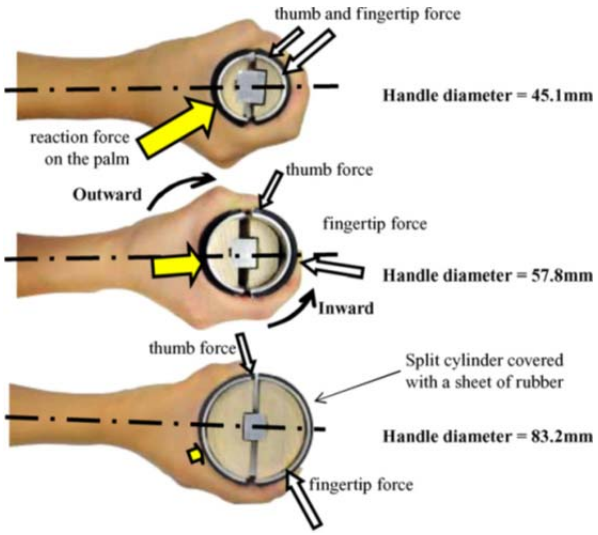

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Fig.2 different diameters forces applied

This means that stronger grips need to grasp less amount of judogi, as shown in the next table.

Torque direction	Torque (N m)	Grip force (N)
Male		
Handle diameter ¼ 45.1 mm		
Grip	–	3347129
Outward	6.372.3	2697106
Inward	7.072.7	213768
Handle diameter ¼ 57.8 mm		
Grip	–	179754
Outward	5.371.3	176743
Inward	7.271.7	212799
Handle diameter ¼ 83.2 mm		
Grip	–	75744
Outward	4.972.1	71726
Inward	6.071.9	60729
Female		
Handle diameter ¼ 45.1 mm		
Grip	–	2047129
Outward	2.371.5	1557128
Inward	2.972.5	1337104
Handle diameter ¼ 57.8 mm		
Grip	–	100790
Outward	2.271.5	108791
Inward	2.972.5	1157101
Handle diameter ¼ 83.2 mm		
Grip	–	48738
Outward	2.471.4	70752
Inward	2.372.0	24720

Tab1 Experimental results

2.4 Grip Mathematical Model

Buchholtz and Armstrong proposed in 1992 a mathematical model of grip that were connected to the distance from the grip centre:

The X-position of the object (judogi) centre of grip may be specified or it can be estimated using the following empirically derived equations for power grasp of circular cylinders. The independent parameters in these equations are hand length (HL) and cylinder diameter (centre of the amount material of judogi) (CD).

The first equation predicts X-location for transverse grasps of circular cylinders (amount of judogi's material):

$X_{judogi} = O.32HL - 0.16\ CD + 0.03\ CD^2 \pm Error$

and the second equation predicts X-location for diagonal grasps of circular cylinders (amount of judogi's material):

:

$X_{judogi} = 0.37HL - 0.59CD + 0.06CD^2 \pm Error.$

In 2003 Sancho bru and co-workers proposed a new 3D model more useful connected to force developed by hand The model considers a contractile element (CE), which is the basic component that generates force, a parallel elastic element (PEE), which is responsible for the passive force generated by the muscle when it is stretched, and a series elastic element (SEE), the muscle tendon unit, which has been considered to be inextensible. The force the muscle exerts (F) can be written as:

$$F_5 = F_{max}(F_{CE} + F_{PEE}), \qquad (1)$$

where F_{CE} and F_{PEE} are the normalized forces delivered by the CE and PEE, respectively.

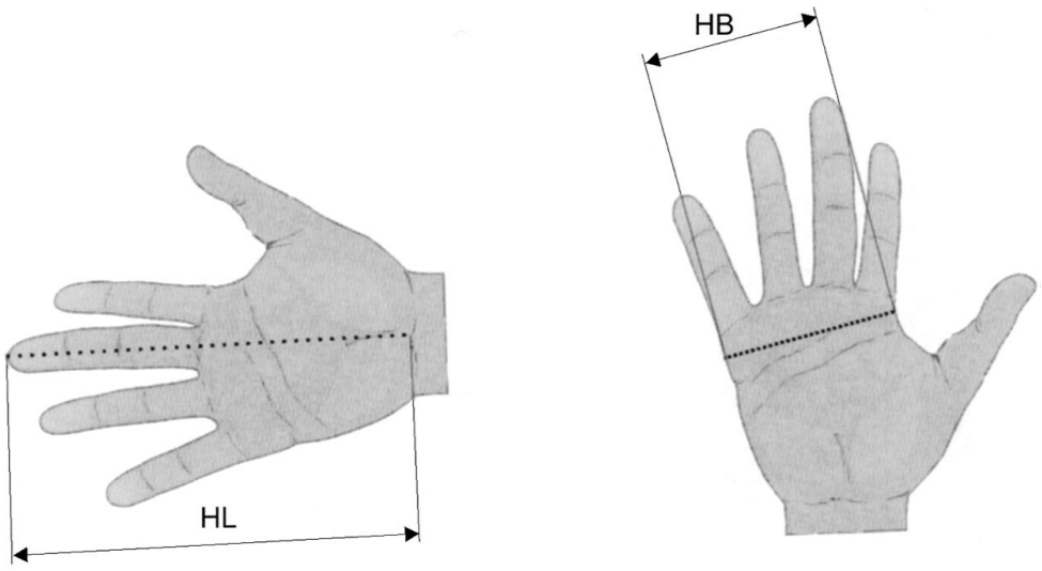

Fig. 3 Parameters used to scale the model: HL .hand length. and HB .hand breadth. (Buchholtz and Armstrong)

2.5 Elbow Flexors

Any sport that involves controlling an opponent, or pulling an opponent toward you will involve activation of the low back, mid back, and….. the elbow flexor musculature. The elbow flexors play a critical role in these sports as they allow for generation/transfer of pulling forces from standing position and controlling forces from laying down positions.
With all the pulling motion that occurs in grappling sports, it can be easy to see why many grapplers can develop rounded shoulders and slightly flexed elbow musculature. A combination of tightness in the elbow flexors and weakness in the elbow extensors, in other words, an imbalance in the structure of one's upper arm musculature can occur. For that reason, elbow extensor training is highly critical for grapplers in order to avoid structural imbalances which may lead to potential injuries.
Modern study were conducted in the US about the endurance and strength of power grips in different elbow position
This last study contradict the results of Mathiowetz et al. who found that stronger grip strength measurements were obtained with the elbow in 90_ flexion.
Higher grip strength in extension of the elbow was also reported by Balogun et al. in a study involving 61 subjects. They also found that a greater strength was obtained when the subjects were standing compared to the sitting position.
In this study Kumar et al. showed that the mean endurance in flexion (90°) was 71.0 N (SD 22.9) and in extension was 68.7 N (SD 27.4).
The mean peak grip strength in flexion (90°) was 262.8 N (SD 73.1) and in extension was 264.1 N (SD 82.0).
T test analysis showed no statistical significance for elbow positions for grip endurance (P = 0.67) and peak grip strength (P = 0.93).The practical implications of this study can also be utilized in judo where grip endurance training may be achieved with the elbow fully extended or in 90° flexion.

2.6 Kinetic superior Chain closed action push/pull

To analyze the push pulling action of superior kinetic chain in kumi kata, both or during shifting on the mat, or during kuzushi-tsukuri phases, it is a very complex matter.
The kinetic chain is called closed if they take contact by the grips on the adversary's body, normally the forces applied to the adversary's body are more often proportional to the GRF (Ground Reaction Forces) produced on the basis of third principle of Dynamics.
Till now no specific study are performed in this field, some data are obtained by French researcher of Poitiers University, during the studies on Suwari Seoi and Uchi Mata.
Not formal model was presented for the Kuzushi –Tsukuri phases, on the basis of the difficult phenomenon that is very far from easy modeling.
In each contest sports, interaction is founded on two separate phases, a common one (shortening of mutual distance) and a specific one (application of permitted ways to seek advantage: strokes or throwing mechanisms) the common part is comparable to a classic "two body problem in central field ".From mechanics we remember:

a) Instead of studying the motion of two athletes, it is possible to analyse the equivalent more simple motion, in the centre of mass reference system, of only one sham athlete gifted with a "reduced" body mass:

$$\mu = \frac{m_1 m_2}{m_1 + m_2} = \left(\frac{1}{m_1} + \frac{1}{m_2} \right) \qquad (2)$$

b) b) In the centre of mass reference system, motion can be described by a two dimensional trajectory on the ground (mat) making use of the coordinates: r e θ.
c) c) Instead of solving the integral of motion by differential equations, it is better to use for the solution the Lagrangian of the system that is potential and kinetic energy.

To single out the general class among many potentials which will describe the common part of interaction, it is better to study the simplest kind of motion with constant angular momentum.
In this case the bi-dimensional trajectory can be treated as one-dimensional because:

$$\theta = \frac{l}{mr^2} \qquad (3)$$

And the interaction force F(r) will be function of distance between sham athlete and Centre of mass of Couple of Athletes system, that is of the sham potential with :

$$V' = V(r) + \frac{l}{mr^2} \qquad (4)$$

With

$$V(r) = -Kr^{-\alpha} \qquad (5)$$

And the ά parameter a will take integral values 0,1,2,3 ...
The sham potential V'(r) will belong to one of subsequent classes of attractive potentials

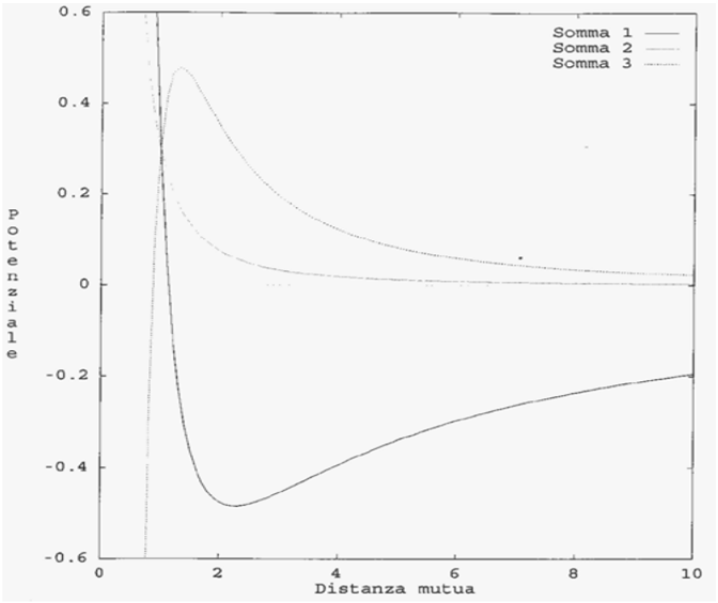

Fig 4 Attractive Sham Potential

This example shows very clearly that only attractive-repulsive potentials as V'(r_1) will be useful to describe the common part of interaction during contest.
The general potential which will describe the interaction will have the general exponential form:

$$V' = r^{-\alpha} + r^{-2\alpha} \qquad (6)$$

From previous considerations, it is possible to declare that the common part of interaction can be described by the curves family showed in a generalised Morse's potential:

$$V = D\left(e^{-2\alpha(r-r_0)} - e^{-\alpha(r-r_0)}\right) \qquad (7)$$

Obviously V' is a particular expansion of this expression.

The specification of a general form of interaction potential is able to give us a lot of useful information:

1) r_o is the equilibrium distance (grip distance in judo).
2) D is the mechanical potential energy in the equilibrium point equal to mechanical mean energy valued in terms of oxygen consumption as ηO_2 (Sacripanti Relationship).
3) It is possible to evaluate the constant a expanding the potential near the minimum point. We get in this case the connection with the harmonic term of expansion or

$$D\alpha^2(r-r_0)^2 = E_c \quad or \quad \alpha = \frac{1}{L}\sqrt{\frac{E_c}{D}} \qquad (8)$$

To know the potential let us go back to the Algebraic expression of force

$$F = ma = 2\alpha D\left(e^{-\alpha r} - e^{-2\alpha r}\right) \qquad (9)$$

To single out the common part of the interaction as a " two body problem in the central field" allows us to utilize an important result of classica1 physics about the mean time value of a few variables (Virial's Theorem); both for motion and interaction it guarantees that, if the generalized force F is a sum of friction and central forces, the mean kinetic energy of the system in time is independent from friction forces
Most interesting is the analysis of motion bounded by grips of one athlete around his opponent. In particular it is possible to show a powerful theorem that gives us information about the central forces that lead to ***closed orbits.***
For every given l this will occur if the equivalent potential V' will have an extreme point (maximum or minimum) at a determined point r_0 and if the Energy E is just equal to V'(r_0) .
In r_0 if V' have an extreme point this means that f' is equal to zero and the force in r_0 will be, remembering the equation

$$f' = f + mr\dot{\theta}^2 = f + \frac{l^2}{mr^3} \qquad (10)$$

$$f(r_0) = -\frac{l^2}{mr_0^3} \qquad (11)$$

Which give the information that the orbit will be closed (pseudo circular) for attractive forces.
Energy can be also evaluated as:

$$E = V(r_0) + \left(\frac{l^2}{2mr_0^2}\right) \qquad (12)$$

These results give for maxima or minima of V' studying hits second derivative if it is concave up V' positive there is a bounded orbit: stable (closed circular) or for V' concave down the orbit is unstable and unbounded.
Normally the Bertrand theorem assures us that closed orbits are possible for forces with the dependence like $1/r^2$.
However if the energy is greater than the energy of a circular orbit, the orbit could be either with open recurrence or also closed, under some conditions. For example developing the force in expansion of Taylor f(r) will be function of a parameter β arising from the question that however the motion is harmonic in $1/r_0$.

$$\frac{1}{r} = \frac{1}{r_0} + A\cos\beta\theta \qquad (13)$$

Where the amplitude A is connected to the Energy deviation from the circular orbit, and β come from the Expansion in term of Taylor of force about the circular orbit around r_0 and substituting into the force equation we have:

$$\beta^2 = 3 + \frac{r}{f}\frac{df}{dr}\bigg|_{r=r_0} \qquad (14)$$

If the radius r goes around the plane, the quantity 1/r goes around β cycles of its oscillation.
One important consideration can born now. It is well known in physics that if the attractive force is represented by a power law $F=-kr^{\alpha}$, then only α = -2 and α = 1 admit closed orbits. It is quite attractive that a Sundman theorem provides a correspondence between solutions to a non linear problem (Newton law) and a linear problem (Hooke Law). He showed that every orbit under Newton Law is image of a Hooke Law orbit under the transformation $z \rightarrow z^2$
Hooke law is more connected to the push/pull action, and then Couple of Athletes system can be modeled as two masses connected, not by gravity force, but more understandable by spring with no gravity force (because the mat stop gravity action) in presence of friction between feet and mat (under push/pull forces actions).
The projection of the Centre Of Mass (COM) trajectory on the Tatami will be a closed planar orbit.
The orbits produced by this duality are shown in next figure.

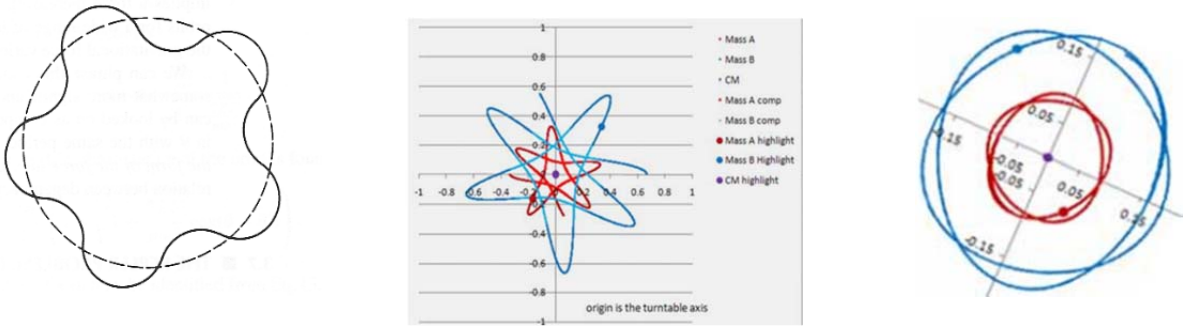

Fig 5 a Newton's Orbit ($F=1/r^2$) of the projection of COM Attacker around the Opponent with Energy deviating slightly (greater) from a circular orbit β=5; b, c, Same orbits for Hooke law (F=-K r) at 1G and 0.1G;

These results are valid with good approximation in two dimensions, like the projection of COM of Athletes on the Tatami. Considering the more real and complex 3D problem it is possible, coming back to mathematical application, to find also a general solution for the shortening distance action, that we call ***General Action Invariants (GAI).***
Considering the infinite situations arising during a competition we are very far from an analytical solution, but the geometrical view makes some light on this very difficult problem and the solution could be accepted considering the still system connected to Athletes Couple, taking in account that for the techniques of physical lever groups Couple must stop for a while.
Very often, with good approximation, the motion for the Athletes Couple System applying techniques lying in the couple of forces group could be considered uniform both linear and circular, in these cases with a right change in the reference system (Galilean Relativity) we are able to bring back the system in still position.

In term of trajectories the first class of ***General Action Invariants*** are almost right lines with specific direction, normally the best right inclination is, in direction of both adversaries' sides, because human body structure is less skilled to resist in such direction. For example into the group of couple of forces, this means couple applied in the frontal plane: like sided O Soto Gari, or Okuri Ashi (harai –barai).
For the other two classes based on rotations, some interesting remarks come from the Poinsot geometrical description of a free forces motion of a body, in such case in fact the motion is like a rolling of the body inertial ellipsoid (without slipping) on a specific plane, remembering that the curve traced out by the point of contact on the inertial ellipsoid is called polhode, while the curve on the plane is called herpolhode.
In a case like judo player, the body is cylindrical symmetrical and the inertial ellipsoid becomes an ellipsoid of revolution, then the polhode is a circle around the Athlete symmetry axis, and the herpolhode on the plane (Tatami) is likewise a circle.
These results in the judo player reference system are real only in the case of free force motion, (it is true considering the couple motion as a whole) but in our case INTERACTION into the couple, as already remembered, there are the push/pull forces and the friction forces acting on.
The problem is almost not analytically solvable for his complexity. However the gross indication (likewise circular trajectories) available for our analysis by Poinsot description is quite acceptable as indication for real situations The judo movements have very complex 3D trajectories, and then it is very difficult to calculate the forces time evolution in space.
The resultant mean push/pull force during shifting motion was already evaluated in the first Sacripanti model as:

$$\Delta F(t-t') = \mu \Delta v \, \delta(t-t') \qquad (15)$$

In fact there are more cashed complexities, like geometrical adaptation of structure of muscles involved that change the amount of contraction force, which make the problem analytically insoluble.

2.7 A Validated mathematical model

Few researches were performed to investigate the impact of changes in muscle geometry and the length–strength and force–velocity relationships on modeling accuracy and spinal loads as it pertains to pushing and pulling tasks.
In the literature it is possible to find the following changes evaluated during push pull action: increasing of the abdominal rectus moment arm by 30%, equating of the external oblique origin to the abdominal rectus, reduction of the area contribution of the latissimus dorsi to include only 43% of the total muscle area, and setting all the trunk muscle's optimal lengths to occur in the anatomical upright position.
All these changes occur in one determined very easy situation man who push/pull a cart in a fixed situation.
If we think to the complexities of 3D trajectories in a judo Throws during a dynamic competitions, it is possible to understand the impossibility to model a such highest complex fast variable situation in which muscles change time in time: force contribution, due to fast change in angle, contraction intensity, due to changing resistance from the adversary, etc.
In the "easy" situation of a fixed position of man at cart, it is possible to evaluate many parameters on change in muscle geometry.
With these updated muscle geometry, the length–strength and force–velocity relationship for the extensors (erector spinae, latissimus dorsi, and internal oblique) and the flexors (rectus abdominis and external oblique) could be empirically derived.

On the basis of these complexities, also in the cart situation, the only way to obtain data connected to the amount of push pull forces is to analyze the GRF obtained for one or two feet support during push or pull action.
In the Biomechanics applied to workers, the only validation of the Lee model (1989) developed for the cart push /pulling was performed in1991, by Andres and Chaffin.
In the next figure it is possible to see the experimental set up of the research.

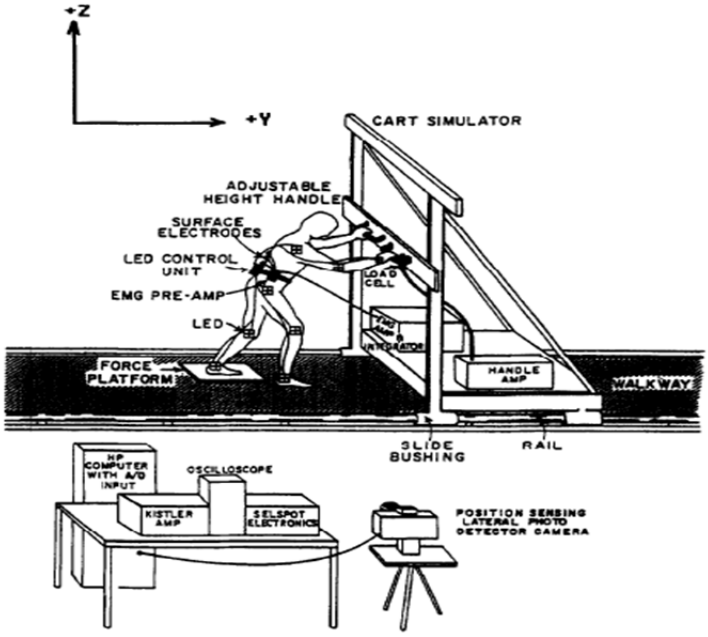

Fig.6 Experimental set up for push/pull evaluation

In such condition were evaluated the push /pull forces with both one leg support, and two leg support, like Judo throws.
In the following foot calculations are detailed below for each case as example, for the lecturer; in such way with the showing of the exemplificative hypothesis it is possible to understand the complexity of the problem.

Single support. Assume:
(1) Two arms act as one (sum Y and Z forces from the separate handles);
(2) Quasi-static equilibrium,

$$\sum F_y = 0 = RF_y - H_y - B_y \rightarrow$$
$$RF_y = H_y + B_y$$
$$\sum F_z = 0 = RF_z - H_z - WB - B_z \rightarrow$$
$$RF_z = H_z + WB + B_z$$

where $\boldsymbol{R\,F_y}$ is the y reactive force of the right foot; $\boldsymbol{R\,F_z}$ is the z reactive force of the right foot. H_y is the total y hand force; H_z *is* the total z hand force; ***B W*** is the total body weight; B_y is the y body inertial force; and B_z is the z body inertial force.
Moments at the foot during single support were not used by the model and were not needed because there were only two unknowns with two equations.

Double support. Assume:
(1) two arms act as one;
(2) quasi-static equilibrium;
(3) moment arms from heel marker for pushing,
from toe marker of rear foot for pulling

$$\sum F_y = 0 = LF_y + RF_y - H_y - B_y$$

$$\sum F_z = 0 = LF_z + RF_z - H_z - B_z - BW$$

Left foot back**.**

$$\sum M_z = 0 = -RF_z * (DF_y) + (B_z + BW) * DCG_y - B_y * (DCG_z) - H_y * (DH_z) + H_z * (DH_y) - B_z$$

$$= -RF_z * (DF_y) + (B_z + BW) * DCG_y - B_y * (DCG_z) - H_y * (DH_z) + H_z * (DH_y) - B_z =$$

$$= DCG_y * (B_z + BW) + DH_y * (H_z) + B_y - DF_y * (RF_z) - DCG_z * (B_y) - DH_z * (H_y)$$

$$RF_z = \left[DCG_y * (B_z + BW) + DH_y * (H_z) + B_z - DCG_z * (B_y) - DH_z * (H_y)\right] / DF_y$$

$$LF_z = H_z + WB + B_z - RF_z$$

where L F_y is the y reactive force of the left foot; L F_z is the z reactive force of the left foot; DCG, is the y distance from the rear heel to the whole body centre of gravity D Fy is the y distance from the rear heel to the **Z** foot force of other foot; D H_y is the y distance from the rear heel to the handle; DCG_z is the Z distance from the floor to the whole body centre of gravity; DH_z is the Z distance from the floor to the handle; and B, is the rotational body inertial force. Similar equations result when the right foot is considered.

Calculation of trunk muscles forces
The calculation of L5/Sl compressive forces and the muscle forces contributing to these forces begins with the calculation of abdominal pressure, because this pressure counteracts some of the contraction force of the erector spinae muscles. An empirical prediction of abdominal pressure was performed using previously reported equations (Lee et ***al.,*** 1989; Chaflin and Andersson, 1984) derived from work done by Morris et ***al.*** (1961).
The moment arm at which F_{ABD} acts has been assumed by Chaffin (1975) to vary as the sine of hip angle, with an erect position having a moment arm of 7 cm, increasing to about 15 cm when stooped over at $\phi = 90$" from vertical (where ϕ_H = the angle from the hip-to-shoulder link to vertical). The argument that F_{ABD} acts parallel to the compressive force on L5/Sl was presented by Chaffin and Andersson (1984).
The line of action of rectus abdominus has also been parallel to the compressive force on L5/Sl in other studies (Schultz and Andersson, 1981; Chaffin and Andersson, 1984). This model assumes that all muscle forces act normal to the shear force to create compression only. Reactive shearing forces are then produced by lumbar facet joints, as described in Chaffin and Andersson (1984).
The following equations were used by the model to calculate back and muscle forces

$$F_C = ESMF + RAMF - F_{ABD} + \sin\alpha * (BW_z + H_z + UB_z) + \cos\alpha * (UB_y + H_y)$$

$$F_s = \cos\alpha * (BW_z + H_z + UB_z) + \sin\alpha * (UB_y + H_y)$$

In the next table are shown the results of the experimental validation of cart push pull model

Table 2. Average and maximum GRF correlation results with linear regression coefficients

Variable	*R*-square	Intercept	Slope
	Average GRFs		
Single support			
RF_x	0.63	−10.9	0.59
RF_z	0.66	27	0.93
COF	0.1	0.15	0.1
Total support			
RF_x	0.67	−12.9	0.55
RF_z	0.12	357	0.26
COF	NS	—	—
	Maximum GRFs		
Single support			
RF_x	0.45	14.3	0.3
RF_z	0.45	164.4	0.78
COF	0.06	0.27	0.05
Total support			
RF_x	0.32	55.4	0.18
RF_z	0.21	435	0.42
COF	NS	—	—

RF_x = horizontal GRF, RF_z = vertical GRF, COF = ratio of RF_x to RF_z. Notice that the correlations during single support exceeded those from the total support phase, demonstrating the improved performance of the model during single support. Also note that the slope parameters were closest to unity during single support with the vertical GRFs.

2.8 Thermal evaluation of judo pulling action

One interesting research performed by Seta Yoshiyuki and co-workers (Cairo 2005) reproduced in simulation the pulling hand actions of a judo player, and surveyed skin surface temperature changes in the muscle areas related to pulling hand actions before and after applying loads to muscles for pulling hand actions. a judo black belt was wound round an indoor column twice and each player held it and made pulling hand actions a total of 30 times with an interval of 2 seconds according to the rhythm of a metronome, the duration of each pulling action being one second.

It was recognized that when the pulling hand, prior to the start of its action, was located near and above the trunk, an isometric muscle contraction mechanism took place at the deltoid and trapezius muscle areas and these muscles became remarkably active and their temperatures rose.

It could also be estimated that the elbow joint remained bent and could not stretch due to the tense belt, and the shoulder joint remained at an abducted position and pulled the belt, applying forces in the joint's horizontal stretching direction and causing no temperature rise at the triceps brachii muscle area.

2.9 Whole-Body Movements

The coupling of grip and load forces of a hand-held object during whole-body motions has been examined in a wide range of activities such as locomotion (Kinoshita *et al*., 1996), stepping up and down (Flanagan and Tresilian, 1994), jumping up and down (Wing, 1996), and pushing/pulling movements (Wing *et al*., 1997).
It was demonstrated that grip force changed in response to variations in load force; grip force increased when load force increased. In addition, increases in grip force and ground reaction force (GRF) preceded the rise in load force; also, the rates of change in grip force and GRF were related both prior to the increase in load force and at the onset of load force.
These findings suggest that there is a task-related functional synergy between grip force and whole-body movements (Wing, 1996; Wing *t al*., 1997).

3 Sensor Motor responses to power grips

Previous studies investigating the blood oxygen level-dependent (BOLD) signal in the human sensor motor cortex during static force (maintained for a few seconds) and dynamic force (repetitive force pulses) resulted in contradictory findings.
Recent study conducted a whole-brain functional magnetic resonance imaging analysis during a visuomotor task requiring the production of either dynamic or static power grip force.
Thereby the study aimed at clarifying whether the BOLD signal behaves differently with dynamic and static force in the primary motor cortex, and whether it behaves in the same way in all areas and regions involved in force production.
In the static condition, participants applied visually guided, isometric grip force on a dynamometer of 20% maximal voluntary contraction (MVC) and held this force for 21 s.
In the dynamic condition, self-paced force pulses of 20% MVC were produced at a rate of 0.5 Hz.
Static and dynamic force production activated an overlapping network of sensor motor cortical and subcortical regions. However, the production of a significantly higher mean static force compared with the dynamic force resulted in a significantly smaller BOLD signal in the contra lateral motor cortex, confirming observations of an earlier investigation.
In addition, it was found that the ipsolateral anterior cerebellum behaved similar to the motor cortex, whereas in all other activated regions the activation during static and dynamic force did not significantly differ. These findings demonstrate that various regions of the sensor motor network participate differentially in the production and control of low static and dynamic grip force.
All these findings raise important questions concerning the interpretation of the BOLD signal with respect to mechanisms of neurovascular coupling. As it is visible into the next figures:

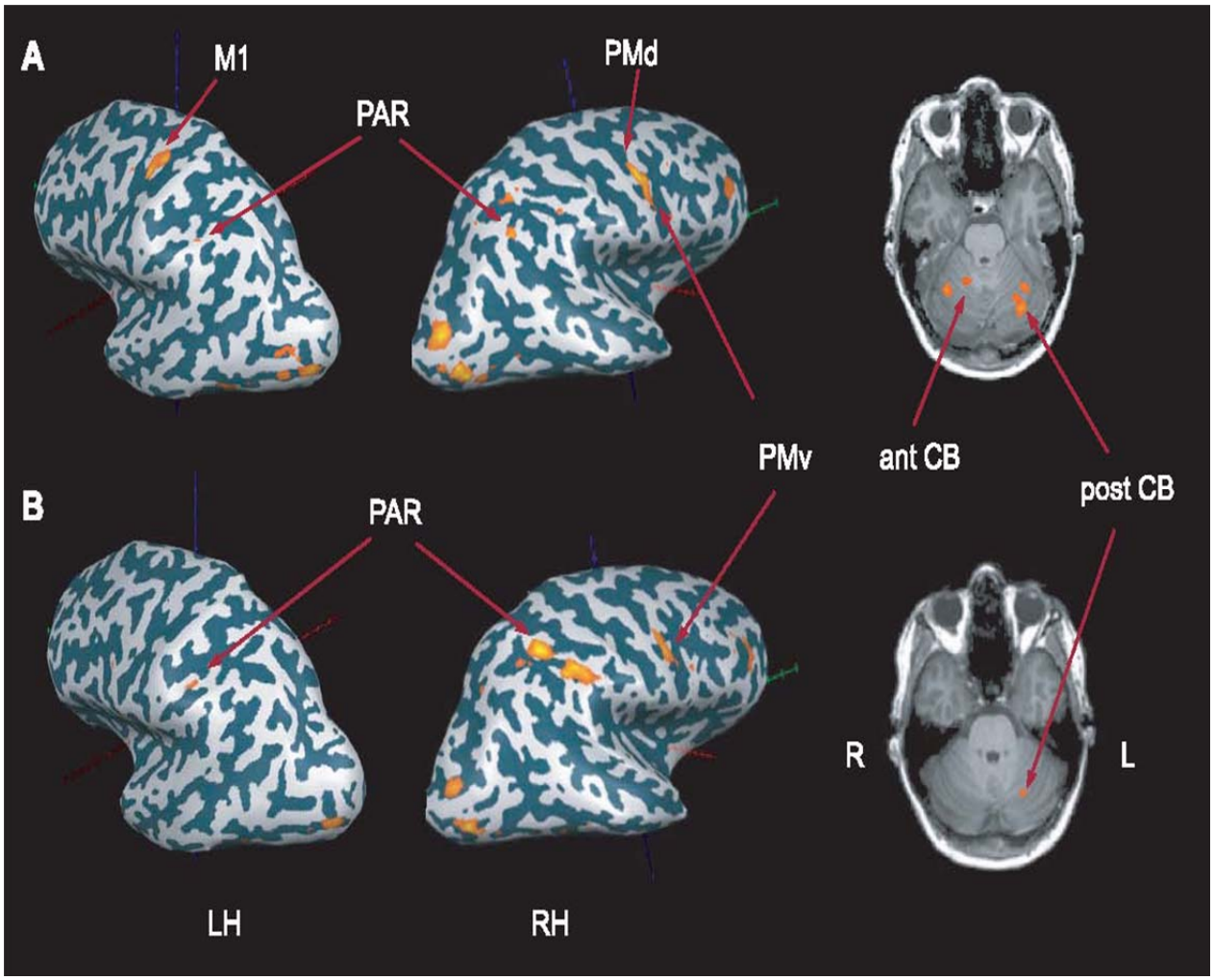

Fig7 different brain's areas activation

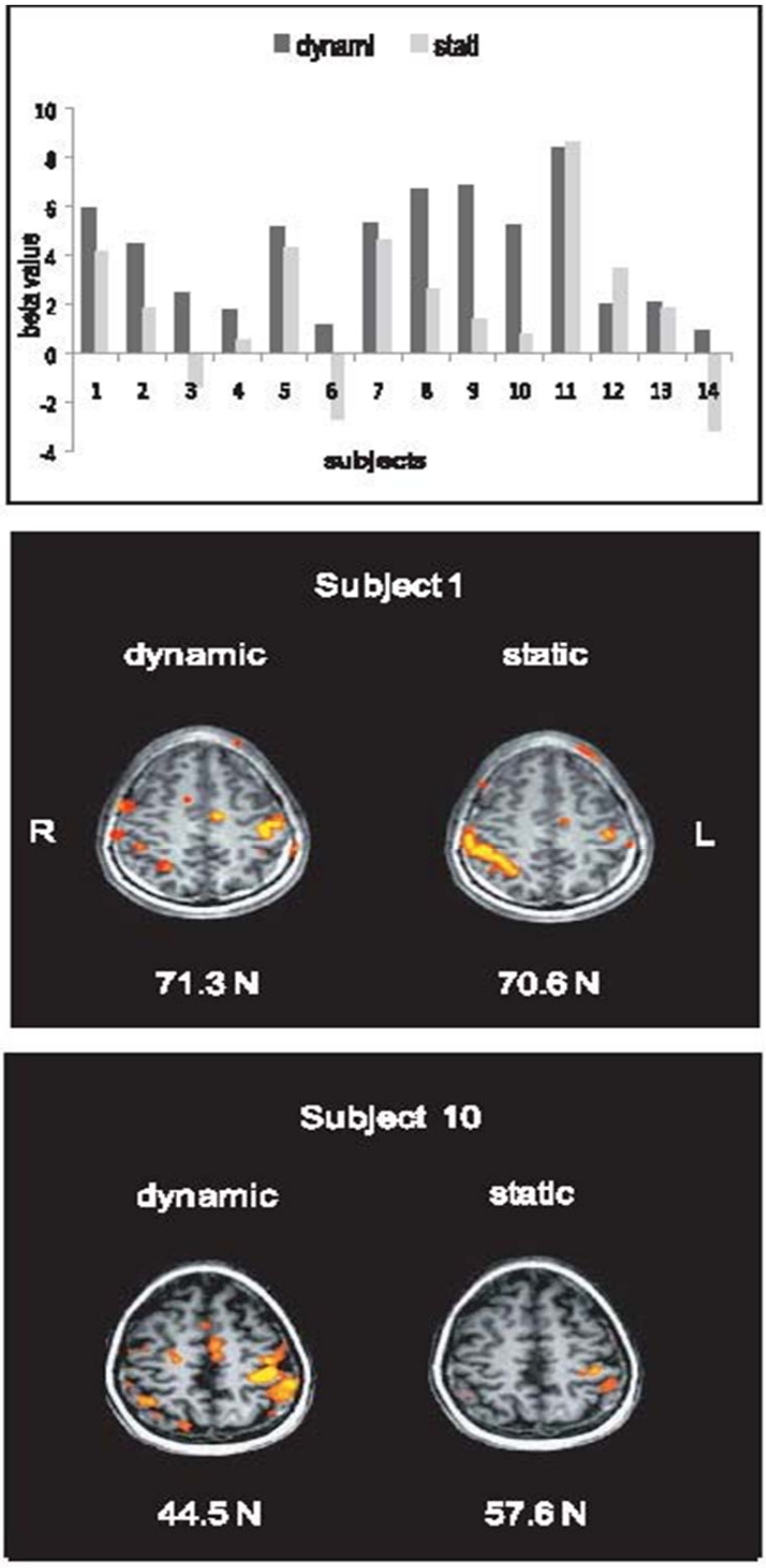

FIG. 4. On the top, individual mean beta weights in M1 for the dynamic (dark grey) and static (light grey) conditions (14 subjects). Underneath, activation maps during dynamic and static force for subject 1 (middle) and subject 10 (bottom). N, mean exerted force in Newton.

IInd Part

Kumi Kata

in

Standard Judo

Teaching and Coaching Field:

4 Kumi Kata - Classical vision

Normally in classical vision the coach or teacher starts from Ki hon kumi kata.
Ki hon kumi kata are the fundamental grips: right hand at the left collar on a level with axilla, to seize judogi with little finger, annular, middle finger, leaving in relax thumb and index; left hand at the right sleeve on a level with elbow sizing a lot of textile. These grips are the most natural and simple

Fig 9 ***basic grip***

There are naturally a lot of variations depending on competitor's build, on style, on positions, on relative strength. It's important to remember that grip has to remain relaxed during the attack or defense in club. The apprentices must study this fundamental grip whether during static training with competitor (*uchi komi*) or during dynamic phase (*kakari geiko*); in fact, it's really important to learn the 'contact' with competitor using *kumi kata*.

The kinetic superior chains (arms) have a four roles in the *kumi kata.:*

1) ***Active role: to transfer to the competitor's body an impulse to realize throwing technique.***
2) ***Passive role: to stop the impetus and the movement of the competitor during his throwing technique.***
3) ***Advising role: to receive information from the adversary's body about his movements***
4) ***Alert role: to receive from the adversary body's movements alert about his attack action***

In the ki hon kumi kata the right arm, in a passive way, takes information about directions of the moving body competitor while the left arm takes the information about direction of the unbalance.
In active way, the right arm affects a motion of translation to the 'masses' of the body competitor, while the left arm brings out the moving action with an accurate directional character.
In a more advanced level is important to study the best possible way to change the grips depending on opportunity, with minimum energy.
Considering in this area only the role of superior chains the following figure shows a connection among different kind of grips on the adversary body.

Fig.10 Kumi Kata Superior Kinetic chain, various positions.

At this level the kumi kata obtains not only the capacity *to sense information about rival movements,* but also the capacity *to impose him own initiative physical and psychological*.
The search for a right energy utilization, takes probably a variation on the balance position of the competitor (with kumi kata, in general, increases muscular body tension) and in the weight relative distribution consequently, it rests on avant-feet.
Some Japanese studies (*Studies on Judo techniques with respect to distribution of body weight)* have proved that the weight distribution, in the tested competitors, was much more forward; you pass from natural and erect position *shizen hon tai* to the natural position with grip on a rival, during this action the muscular tone increases and the movement body becomes more dynamic, these positions ought to give the action very fast and a right start position in the attack.
The consideration of the dynamic balance in the athletes couple, like a single bio-kinematic grouping, proved that this couple is in permanent balance, through a whole of tensions, tractions and restraining reactions, even if each athlete has a position of abnormal unstable balance.
In the light of these facts, you can make a correct analysis of competition only if you take into account athletes, considered like an exclusive whole: the biodynamic grouping ***"athletes couple"(couple of athletes)*** For this reason is very fundamental, realizing a technique, to use at best the concept of *relative distance.*
Better distance to realize a technique is in the *balance* between optimal **Time** to have a contact and the available **Space** to realize the attack movement, preserving a large **inertial momentum** in the athlete's couple.
The relative distance between athletes in biodynamic grouping can be annulled to realize a technique by a *taisabaki* or controlled along longitudinal axis by *guard position*. During a competition there are many sorts of approaches which regulate relative distance between two athletes. In order to didactics, you can group them in three classes:

4.1 Guard Position

Diagonal guard positions

The athletes are placed so that relative distance between them is from one side almost zero, while on the other side is large and sometimes open.

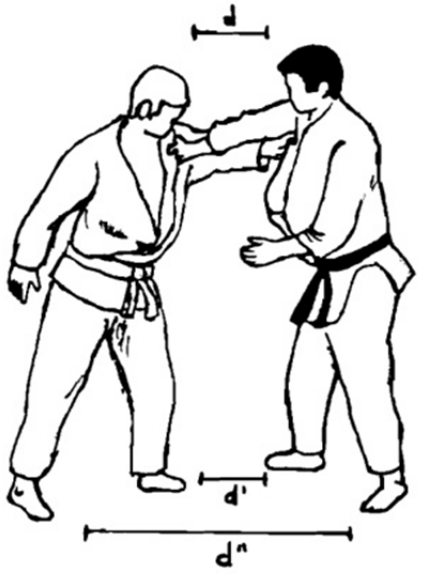

Fig 11 ***diagonal guard d=d'<d''***

Normal guard positions

Two athletes are placed so that relative distance between them is more or less the same on both sides. In this kind of guard positions there is also the one called by Japanese SHIZEN HON TAI

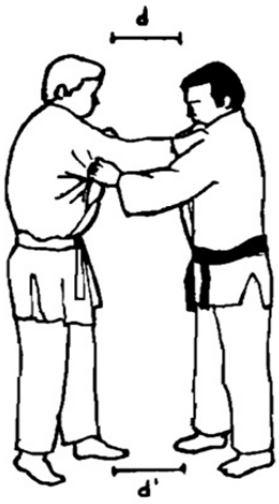

Fig.12 ***Normal guard d=d'***

Curled up guard positions

Two athletes are placed so that relative distance between them behind is almost null, while on a level with hips is larger possible, these guard positions are called by Japanese JIGO TAI.

Fig.13 ***Curled up guard d<<d'***

To everyone is associated a special group of *Kumi Kata*, to each of these guard positions will coincide a particular strategy competition and the capability to realize some throwing techniques.
In the dynamic field to these guard positions are connected often a well-defined cadence or rhythm of attack in the biodynamic grouping "athletes couple".
Nowadays, with high professional specialization at an international level, the evolution of superior Judo is present above all in two well-determined biomechanical aspects:

1) ***Increasing physical strengthening***
2) ***The Kumi Kata predominance, which originate from this approach.***

From the study of world championship, Olympic games and of other important competitions and from *shiai* experience, points out some international competitors became a specialist about particular *Kumi Kata* to be able to effect their special technique (*Tokui waza*) in dynamic conditions. From the study of initial phase of these competitions you can comprehend the match crucial moment is "*the fight to impose one's Kumi Kata";* many times, before *Kumi Kata,* there are some "*hand jumps*" which stabilize some *safety Kumi Kata* and permit to pose in profile towards adversary; in this way, the rival hasn't a great surface to grip and to attack, and so he's able to avoid the eventually believed dangerous and unfavorable grip (Diagonal guard positions).
After this phase, the athlete tries to build carefully and slowly his favorite position of *Kumi Kata,* cause a little absent-mindedness and a brief weakness, during control of points of contact(hands) moving, becomes a decisive chance to win a match for a technically well-prepared adversary.
Nowadays, the realization and definition of a special *kumi kata*, during a competition, is considered an art in itself and a fundamental phase of "*Dynamic Superior Judo".*
In the previous dynamic analysis we have already talked about important role which hands, as points of contact, play; therefore, only by an arms action, with a right body moving, will be possible to unbalance one of the athletes in biodynamic grouping "athletes' couple".
Many times, today, the defeat is much more in a *kumi kata* error instead of a moving, in fact the errors on the *shintai*, like feet from close up, jumps, crossed feet, aren't so important because of dynamic athletes balance; while *kumi kata* errors are directly reflected in the balance and in the

energy transfer to the single athlete. During "superior dynamic Judo" practice, the *kumi kat*a hasn't only an informative role but, above all, it becomes an essential psychological aspect about imposition of one's will to the adversary to cross his reactions.

All these concepts produce some fundamental characteristics required by every athlete:

--increasing physical strengthening
--increasing acrobatics capacities
--during a match high and constant "rhythm"
--capacity to use one's special kumi kata, after to have had the adversary kumi kata
--to study the opportunities realizing one's special kumi kata
-- Continual adjournment about Renzoku waza originated from one's special kumi kata

The number of *kumi kata* is infinite, but it's also possible to classify them in groups in accordance for example with the classification utilized by French Federation (FFJDA) (Les Kumi-Katas).

RIGHT KUMI KATA:

A) Right-down Kumi Kata
Left hand catches right sleeve
Right hand catches left collar, on a level with hips, over the belt

B) Right-normal Kumi Kata
Left hand catches right sleeve
Right hand catches left collar, below clavicle

C) Right-up Kumi Kata
Left hand catches right sleeve
Right hand catches left collar at the back of neck

LEFT KUMI KATA:

A) Left-down Kumi Kata
Right hand catches left sleeve
Left hand catches right collar on a level with hips, over the belt

B) Left-normal Kumi Kata
Right hand catches left sleeve
Left hand catches right collar, below clavicle

C) Left-up Kumi Kata
Right hand catches left sleeve
Left hand catches right collar at the back of neck

MIXED KUMI KATA:

A) Mixed-normal Kumi Kata
Both hands catch both collars below clavicle

B) Mixed-down Kumi Kata
Both hands catch both collars on a level with hips

SLEEVES KUMI KATA:

A) Both hands to both sleeves

KUMI KATA WITH OPPORTUNITIES:

A) Free hand
The other hand at sleeve
The other hand at collar

CHANGE-OVER KUMI KATA:

A) with one of the hands at the belt
With one hand catch collar
With other hand at the sleeve, by the same side

CROSSED KUMI KATA:

A) With right hand at the edge of right sleeve
With left hand at left collar or vice-versa

4.2 Grips and Their Objectives

The objectives of gripping are two

1. place one hand(Tsurite) in position to push Uke back toward the mat
2. Secure a locking hand (Hikite) that will prevent the defender from getting away from your throwing action

The tsurite hand cannot be placed without preparation. Place it by degree grabbing the nearest part of opponent's judogi, sleeve, elbow, or lapel; then grasping the adversary's judogi push down. When pushing down keep your gripping hand tucked in close to your side and move your body (gripping side) lowering it under your grip.
The reaction to the push will expose part of your adversary's judogi to your grips, then, in such way, it is possible to improve your grip position

Hikite – Tsurite

Gripping methods fits into two categories within jacket work:
1 Hikite (the main pull) Sleeve grip "the working hand" or "Long pull"
2 Tsurite (the drawing hand) Lapel grip "the playing hand" or "short pull".

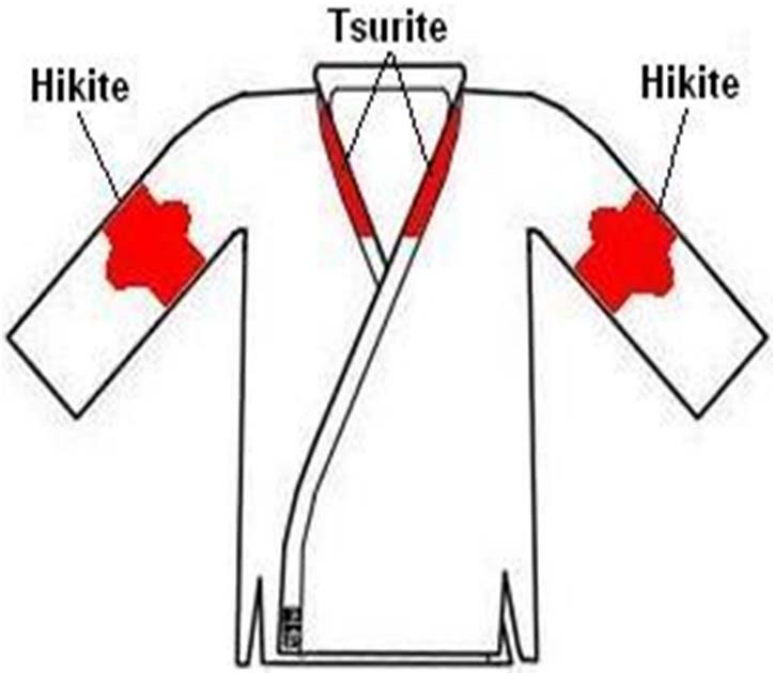

Fig 14 Specific Judogi Areas

A few comments are in order regarding the definitions of hikite and tsurite.

HIKITE

The pulling hand is utilized to transmit tension to uke's shoulder joint. The hikite pull is the a large amplitude pull, that normally account of 75% of the forward unbalance. Properly done by Tori, it results in the desired upper shoulder girdle rotation of the Uke, when combined with the action of the tsurite hand. Normally this action could be developed in two dimensions:

1. Vertical dimension given by position of grip in on location between elbow and shoulder
2. Horizontal dimension of the grips on the arm (internal Vs external; upper Vs lower)

The Hikite traction have the goal to open the angle between homers and trunk of Uke.
If the grip is placed just above the wrist area when the pulling is applied, the Uke's arm must first essentially lock straight at the elbow before the shoulder joint senses the fully applied tension necessary for the shoulder girdle rotation.
Too high a grip on Uke's arm is undesirable since this betters the amplitude but worsen the mobility of the Tori arm.
Generally, optimum arm pull on uke's arm should be initially horizontal and parallel to the mat surface. Contrary to popular belief, raising the Uke's arm above the horizontal limits the unbalance effectiveness of the action. It is important to remember that the overall pulling is accomplished and effective with Tori using his/her upper body in conjunction with the pulling hand.
This is usually rotation or translation of the trunk.
Special Use: the Hikite arm can be also utilized in a complete different way pulling down the adversary arm along his body, in order to apply the maximum pressure on one adversary's side (Rotational Application).

TSURITE

Tsurite is the pulling force action to lapel of judogi, normally called short amplitude pull, it could account for the 25% of forward unbalance.
Tsurite comes from the word tsuri meaning to fish and incorporates the idea of drawing an opponent off balance, just as a fishing rod bends when it draws a fish out of the water.
It is very important for the right application of Tsurite movement that arm turns at elbow and shoulder level.
A grip near the head helps mobility for unbalance but needs more force and gives less mobility for arms and legs.
Inversely a low grip gives less amplitude for unbalance, but also less force and helps arms and legs mobility.
The strongest position of the lifting hand is when the elbow of the Tori is placed in contact with the upper body with the hand located directly above it.
The weakest position of the Tsurite is when the arm is fully outstretched.
The hand has zero lifting capability in this position.
Experienced athletes in competition usually made grip change that afford advantage than a disadvantage in throwing capability.
Most athletes usually vary the Tsurite grip far more often than the Hikite grip during tournament play.
Special Use: the Tsurite arm can be also utilized in a complete different way, blocking and pulling down the adversary shoulder or one his body's point along, in order to apply the maximum pressure on this point blocking the adversary's side (Rotational Application of Throws).

5 Advanced Analysis for Standard Competition

5.1 Technical Steps in competition

It used by most National Federations' analysts to divide the whole competition in technical steps: The basic step in the time domain is not fixed, because the analysts normally use technical finding to analyze the competition, normally there are used five or six technical steps.
In our paper we use the subdivision in six technical steps (Francini and coworkers):

1) *Matte* – a period of interruption, when the referee calls *Matte* to discontinue any activity of the judoka;
2) *Preparation* – a period of movement, observation and non-contact preparation;
3) *Grip* – a period of the match in which the judoka disputes for the best grip (*Kumi-kata)*, when there is contact with one or both hands;
4) *Throws* – a period in which the judoka executes a technique or throw during standing combat (*Tachi-waza*);
5) *Fall* – the moment of the fall (*Kake*) when the analyzed athlete falls to the ground being possible that both judokas fall as a result of the application of *technique*.
6) *Groundwork* – any combat that takes place on the ground (*Ne-waza*), when strangle or arm-lock techniques are applied with the aim of immobilizing or finalizing an opponent.
One other model for example from England is the Hajime –Matte model proposed by Karen Roberts always in six phases like:

1) *Mobility (shifting alone)*
2) *Kumi Kata*
3) *Preparation*
4) *Tachi waza*
5) *Transition*
6) *Ne waza*

It easy to understand that competition is a linear connection of these steps.

$$C = \sum_{i=1}^{6} \quad \sum_{k=1}^{N} \frac{\mu_{ki}}{1} \left(\tau_1^{\beta_1} + \tau_2^{\beta_2} + \tau_3^{\beta_3} + \tau_4^{\beta_4} + \tau_5^{\beta_5} + \tau_6^{\beta_6} \right)$$

In which τ is one phase μ the number of the specific phases in each completion, and β is the existence factor of such phase in each competition = 0 or 1 (yes or not).
In Judo, the distance in the Athletes couple depends from the Kumi-kata and the feet position, determined by the guard position. These two parameters change many times during competition and in very important way during attack.
"Rigid" grips are negative for the distance variations, and they are wrong for the multiple attack capabilities.
The special Kumi kata can be considered psychologically encouraging, but from the other side it not lets to attack in many different directions.
The basic Ki hon kumi kata lets to apply more attacks in different directions and it can be considered more generalist
Analytical studies on the *Kumi Kata*, used in competition, like right, left, mixed *Kumi Kata*, studied in Japan (*Analytical studies on the contests performed at the all Japan Championship Tournament)*

If we think deeper, the motion on the mat, it is the results of many pushes and pulls applied by the grips, but it is not possible to apply push or pull without the contact to the mat by the feet.
Thinks for example to apply the same push-pull forces in the couple system, wearing roller-skates, then obviously it will be impossible to apply anything!
Now after that, it is understandable the meaning of the so called "***Biomechanics Grips Paradox***".
What is the most important aspect of the Grips (Kumi Kata)?
Feet Position is the Grips most important aspect!
Arms position is essential only in defining the forces' directions to throw the adversary, but without a strong support base the arms position is unimportant.
This is a new kind of fight vision, not to see simply in short way: or the arms position, or the bodies' relative position, or the power applied to the adversary.
But the advanced way is to approach the system as whole seeing at the Couple of Athletes and not at the single athlete.
This new vision is the right biomechanical vision, or in other words the advanced modern vision of the Judo competition.
This other aspect, very important, from the strategic point of view, as seen, came from the study not of the single athlete, that coach normally perform during competition, but from the analysis of the whole system "couple of athletes".
If the competition is approached in this way many interesting adversary's aspects, both from the strategic and technical (Throwing) point of view get out from the system observation.

5.2 Competition Invariants
The ***Competitive Invariants*** singled out by the author are the so called "Guard Position" which are the hold or grip positions that the couple of athletes closed system got during the fights. (see Biomechanical analysis of competition)
These positions could be classified on the basis of two relative ranges: distance between the heads, and distance between feet in two main groups connected to the shifting velocity, each group could be divided in three subclasses related form left to right to the shifting velocity of Couple increasing.
These positions are strongly connected to the preferred fighting motion pace of each athlete, which reveals a lot of technical information about the fighting preference and the special class of Throwing utilized (Tokui Waza). Normally during competition the normal athletes'attitude changes:
1) They lower their position, to stabilize
2) The body superior part (head and shoulders) is closer the inferior one's (hip and feet) is farer
3) They increase the mutual control.
Generally speaking the control increase by a strong fixation of wrists, simultaneously drawing down by arms and using one's weight to slow down the adversaries' movements, but without tense the arms. The hikite arm is utilized during attack to open the adversary guard, in defense by the control of cuff jacket; it is able to stop the adversary's attack.
It is interesting to remember the golden rules of Kumi Kata stated by Kazuzo Kudo in his superb textbook Dynamic Judo: " *Do not tense your arms, but stand as loose and flexible as possible. Not only is this nearly impossible for beginners, it is trouble-some for those men who made considerable progress in judo. The truth of the matter is that as you recklessly thrust your arms out and pull them in during practice you will naturally come to understand what the technique is all about and will master the use of your arms. When this happens you will be able to tense your arms, when you need to and relax them, when you do not. An important thing for you to understand at this stage is that you apply judo techniques as you move back and forth and from side to side together with your opponent and that you must relax your arms as you do so."*

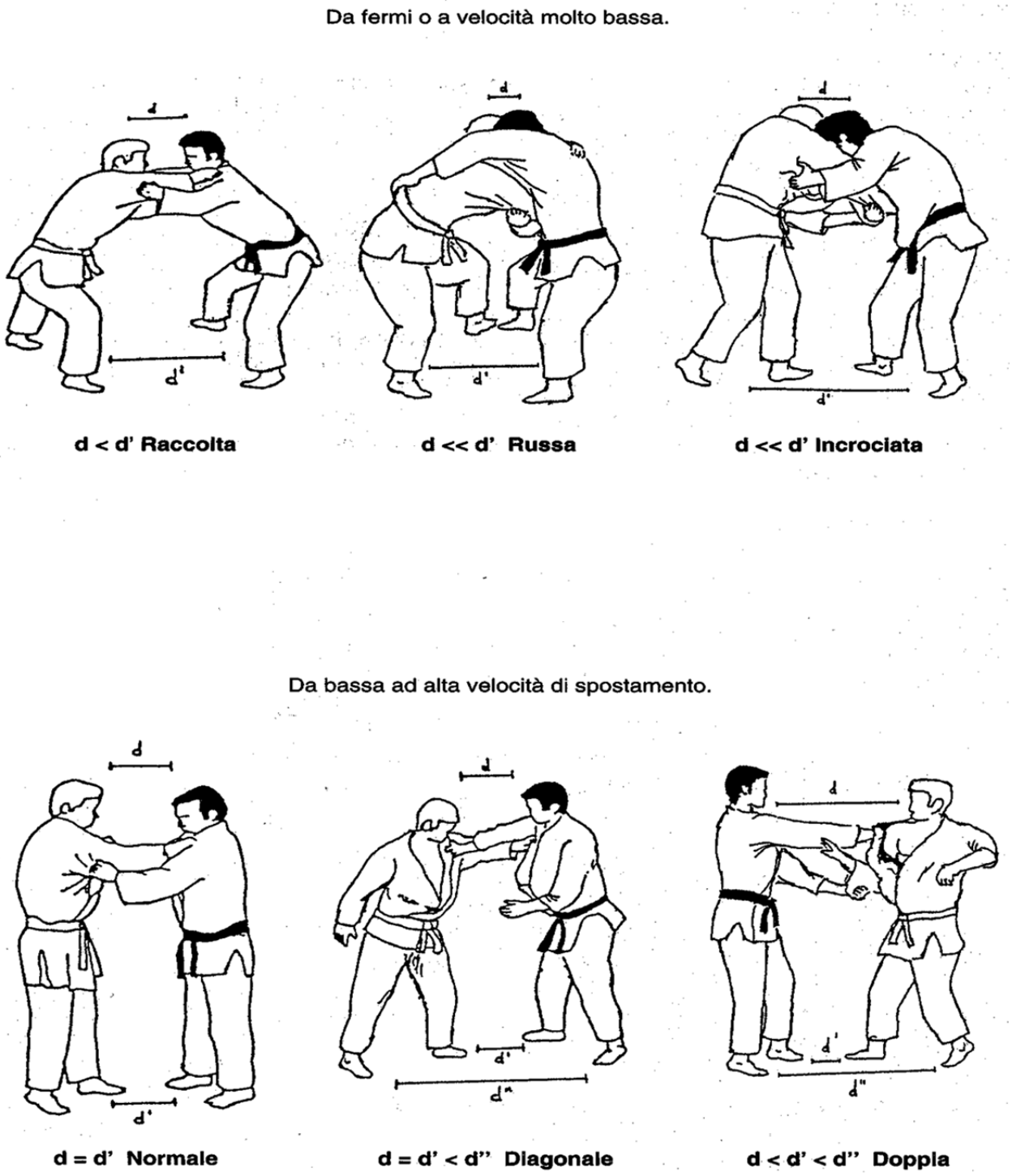
Da fermi o a velocità molto bassa.
d
d'
d < d' Raccolta
d << d' Russa
d << d' Incrociata
Da bassa ad alta velocità di spostamento.
d = d' Normale
d = d' < d'' Diagonale
d < d' < d'' Doppia

Fig.15 ***Six Classes of Guard Position (Competition Invariants) related to the couple shifting velocity. (Sacripanti)***

In particular the author founded six classes of "***Competitive Invariants***", connected to the increasing couple speed, in which it is possible to collect together all the infinite grip positions that the couple of athletes closed system could built.
These are all the position classes that the couple of athletes closed system could built. Biomechanically speaking each position is connected to the Tokui Waza and the pace that the Athlete likes to apply in such motion situation.

Fig.16-21 The Six Classes of Guard Position related to the couple shifting velocity in real competition. (Finch, Zahonyi)

Then if the coach sees at the Guard Position (***Competitive Invariant)*** and understand the pace motion of the adversary he can preview the biomechanical class of his preferred Tokui Waza.
Remembering that the biomechanical classes are connected to the shifting speed, or that is easier to apply Techniques of couple of forces at high shifting speed, than techniques of the physical lever, it will be easier, for example, to recommend to his own athlete to change the motion pace, in such a way as to increase the difficulty for the adversary to apply the Kuzushi-Tzukuri phase connected both with his Tokui Waza and with the preferred speed.
Today with the fight evolution elite athletes are able to change guard position during fight, by the way the connection speed throws is always valid and useful to contrast the pace motion changed.
Obviously in such situation to attempt the victory means to connect all these information in a whole strategic approach to fight.
How this information, without singling out the concept of Competition Invariants, is present in Japanese Judo it is easy to see in the following recommendations of Sato and Okano in "Vital Judo" about Uchi Mata, they present five methods to solve the Kuzushi-Tzukuri phases starting when a small Tori attacks Uke that is in traditional grip in Ai Yotsu, two methods when the opponent stands with both arms rigidly out-stretched used mainly by Tomio Sasahara, one when the opponent has retracted his hips and assumed a position of stubborn resistance, the last favorite method of Hirobumi Matsuda.
In these differentiated attacks connected to the Uke's body position there is the ground of both concepts: Couple of Athletes System and Competition Invariants.

5.3 Two “outmoded” grips

In these competition invariant, there are “outmoded” two types of special grips.
The first one is the famous ***“double lapel grips”.***
This grip is common in European and Korean judo; it allows fighters to switch from left to right but sacrifices control of the sleeves. The double-sleeve grip is also seen occasionally, as it allows players to attack with sode-tsuri-komi-goshi on both sides. It was a much more popular grip in the years when there were no weight categories and was often used by smaller men against larger opponents.
However it is one of the most powerful grips that take the control of the Uke’s trunk. In such situation the main concern of Tori is to control Uke’s shoulders, this control obviously limits the rotational capability of Uke , not allowing in easy way the application of all throwing techniques that are based on the full rotation of Uke’s body.
The weakness of this grip can be revealed by the normal condition that all two opponent’s arms are free.
But the trunk control may result more important than this potentially drawback, because today it is not allowed to grab directly the leg in competition.
In the first of the two next figures it is shown Wilhelm Ruska with his preferred double lapel grips in one world championship final

Fig 22 double lapel grip

Fig 23 double sleeve grip

The second one is the less famous but still sometime effective “***double sleeve grips***”
This grips is not useful for shifting in competition but is very effective applied to some specific throwing techniques like the well known Sode Tsuri komi Goshi.
In figure is shown an effective attack in Sode Tsuri Komi Goshi brought by a Korean athlete.

5.4 Relations between Gripping Methods and Favorite Tricks in Judoists

Some Japanese researchers analyzed the connection between grips and tokui waza of the athletes. Yoshiyuki Seta and co-worker (Daito College of Medical Technology) and Noboru Hashimoto and co-workers (Tokyo Metropolitan Judo Sekotsushikai Incorporated)
As well known, gripping offer the preconditions for a player to apply throwing to the opponent or defend himself against him.
Every player has his own most favorite gripping pattern and more often is confident of beating an opponent or leading the match if he can successfully apply this gripping pattern to the adversary.

Regarding the grip positions in hanging and pulling actions, players who grip the back or back collar of the opponent's suit in their hanging action were classified into:
Group A' (hang), those who grip the side collar
Group B' (hang) and those who grip the front collar
Group C' (hang), while those who hold the opponent by the collar or armpit area
in the pulling action were classified
Group A (pull), those who hold the opponent by the area near the elbow joint
Group B (pull) and those who hold the opponent by the area near the sleeve.
At the end they connected to each group previously classified the specific techniques applied by the athletes.
Obviously the connection was in agreement to the biomechanical capability to apply the technique with the specific grip.
Three interesting papers from Korea by Kim, Eui-Hwan and co-workers analyzed not only the connection between the same techniques (Morote Seoi Nage and Uchi Mata), with different types of Kumi kata and two different opponent's height
The most interesting results applied to static situation showed different projection times, ranging between 1,45 s. and 1,56 s. in connection with the two kind of grips.
Obviously all the posture variable was changing from one type to the other. Also for Morote Seoi Nage the time was different but some postural parameters, like elbow angle, remaining fixe

Fig. 23-27 Uchi Mata Korean Study connecting throw and different grips

Regarding to the use of Tsurite and Hikite in Judo Throws Mr De weels notices that approximately 14 of the officially recognized throws by the Kodokan do not make use of the Hikite/Tsurite combined hand actions of the orthodox/classic grip defined before.
Although physical lifting or pulling may be used during the performance of these throws, the actions differ from the conventional use of the hands as used in the classic sleeve and lapel grip. In particular, the unique gripping will be highlighted to show how the throwing technique differs from others which make use of the classic sleeve and lapel grip Paragraphs. A survey of 82 judo players was taken to determine their most favorite gripping position in hanging and pulling actions and whether they are a right- or left-hander, as well as their best or strongest technique.

Group	Method	Use	Surveyed No.	Favourite Techniques
A	Back grip / back collar grip	Hanging action	31	O soto gari, Uchi mata, Hari goshi
B	Side collar	Hanging action	30	O soto gari, Uchi mata, Ippon seoi nage, Tai otoshi
C	The front collar	Hanging action	21	Ippon Seoi nage, Tai otoshi, Ko uchi gari
A	Collar or armpit	Pulling action	12	O soto gari, Uchi mata, Harai goshi
B	Near the elbow joint	Pulling action	41	O soto gari, Uchi mata, Hari goshi, Ippon seoi nage, tai otoshi,
C	Area near the sleeve	Pulling action	29	Ippon seoi nage, Tai otoshi, O uchi gari, Ko uchi gari, Tomoe nage

Tab 3 Grips and throws

Group B (hang) is most effective of all the hanging grips in breaking the opponent's stance and can lead to every kind of subsequent technique.

Group C (hang grip is considered more effective than any others in breaking the opponent's stance by holding him by the front collar and actively using hanging actions to facilitate throwing down the opponent after creeping under him.

In Group A (pull) – gripping the collar or the area around the armpit in a pulling action will most facilitate a player to apply the subsequent Maki komi waza or Katsugi waza trick including the Ippon seoi technique achieved by gripping one-side of the collar.

In Group B (pull), grip position in the pulling action allows a player to most effectively use his power and also plays an important role in protecting himself from the opponent's techniques. Further this grip position offers a stable basis to easily apply all subsequent techniques to the opponent.

In Group C (pull), this grip position allows more frequent use of Katsugi Waza and Ashi Waza techniques than others as gripping the opponent's sleeve in the pulling action will restrict his free and active use of hanging actions and make his armpit area defenseless.

5.5 Gripping methods and anterior cruciate ligaments damage

It is very important to note for coaches that there is a relationship between gripping methods and damages to anterior cruciate ligaments of legs.
This situation will be actual and dangerous when both athletes fight in Kenka –yotsu situation.
In one paper with this specified study, (The common mechanisms of anterior cruciate ligament injuries in judo: a retrospective analysis) koshida and co-workers 2008, the number of anterior cruciate ligaments injuries when the participant's grip style was opposite to the style of the opponent (left kumi kata against right kumi kata, ***kenka-yotsu*** style) (28 cases) was significantly greater than when the participant's grip style was the same as that of the opponent (ie, ***ai-yotsu*** style) (15 cases).
Another very important finding was that the number of anterior cruciate ligaments injuries was significantly higher when the participant was attacked by the opponent, than when counterattacked or when attempting the attack ($p<0.001$).
In addition, being attacked with *osoto-gari* was revealed as the leading cause of anterior cruciate ligaments injury incidence among the participants (16.8%).
The final finding of this paper was that grip style may be associated with anterior cruciate ligaments injury occurrence in judo.
In addition, it is possible to decide that direct contact due to the opponent's attack may be a common mechanism for anterior cruciate ligaments injuries in judo.

Fig 28 Ai Yotsu

Fig 29 Kenka Yotsu

Time steps:

5.6 Before Grips

One very interesting work performed by Pierantozzi e co-workers was applied to study the phase before the effective grip.
This analysis performed on fights in a high level competition (world championship finals 2007) was performed to know how much was relevant the first grip in judo fighting.
"First grip" was defined the first valid contact between the two fighters.
It is the hand that grips first with effectiveness the judogi or a permitted body's area of the opponent.

We mean "effective grip" the contact that permits a right interaction between the two judoka in order to:

1. transfer the impulse to the opponent to perform a throwing technique;
2. block the movement of the opponent;
3. Perceive information about the movements of the opponent.

The objective of the study was to analyze:

- the fighting time for the first grip :

    a) the time between hajime and the first grip,
    b) the time to remake the grip during the combat phase in tachi waza, when the fighters loose the grips;

- average number of kumi kata fights during one match;
- judogi percentage area of first grip.

The judogi was divided in 7 areas where the fighters could grip:

- Lapel (red outlined area)
- Sleeve (blue outlined area)
- Hand-wirst (light blue outlined area)
- Back (lilac outlined area)
- Racket skirt (green outlined area)
- Leg (yellow outlined area)
- Belt (the belt)

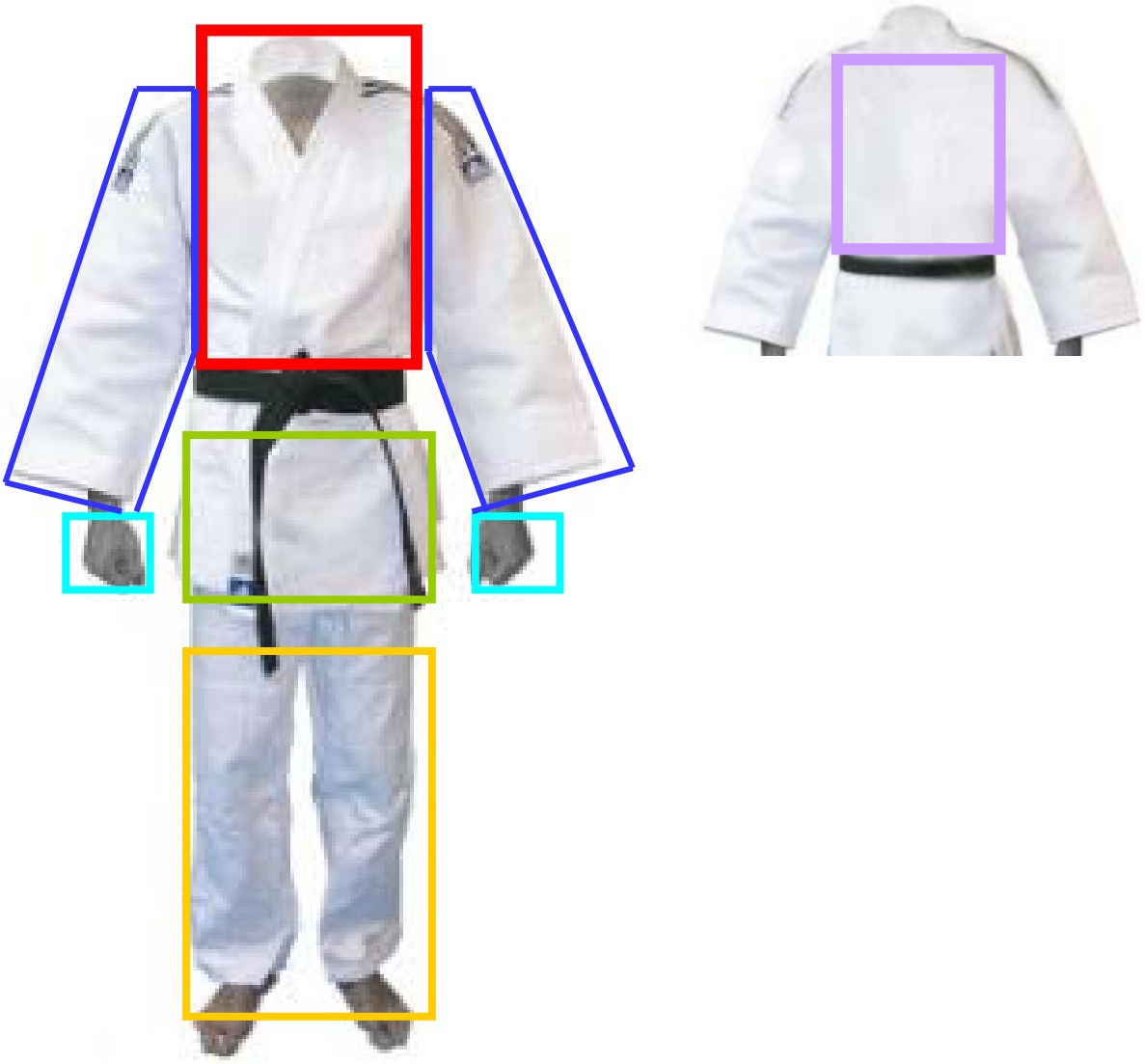

Fig. 30: Judogi area

Because during the 18 fights analysed nobody gripped the belt, this area was excluded in the statistical analysis, and only 6 areas were analyzed .
In the case that there had been more areas gripped at the same time (less than 1 second) all the areas considered.

RESULTS

	Females	Males	Total	Females	Males	Total
Lapel	106	101	207	55.8%	46.1%	50.6%
Sleeve	23	29	52	12.1%	13.2%	12.7%
Back	11	22	33	5.8%	10.0%	8.1%
Wrist-Hand	16	55	71	8.4%	25.1%	17.4%
Jacket Skirt	0	3	3	0.0%	1.4%	0.7%
Leg	34	9	43	17.9%	4.1%	10.5%
Total	190	219	409	100.0%	100.0%	100.0%

Tab.4: Number and percentage of first grip by grip area and gender

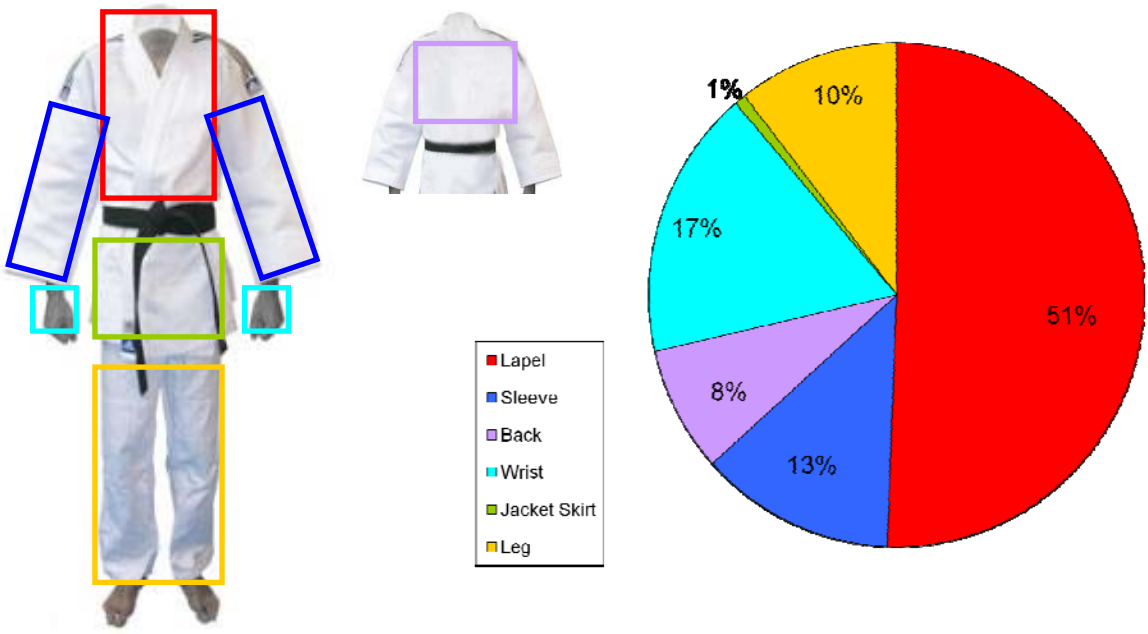

Fig. 31 Total percentage distribution of first grip in the 18 finals

Some results were high interesting:
Males and females have had different approaches in the choice of the first grip.
For both genders the preferred area was the lapel, but the second one was the leg for the females and the wrist- hand for males (Fig.28).

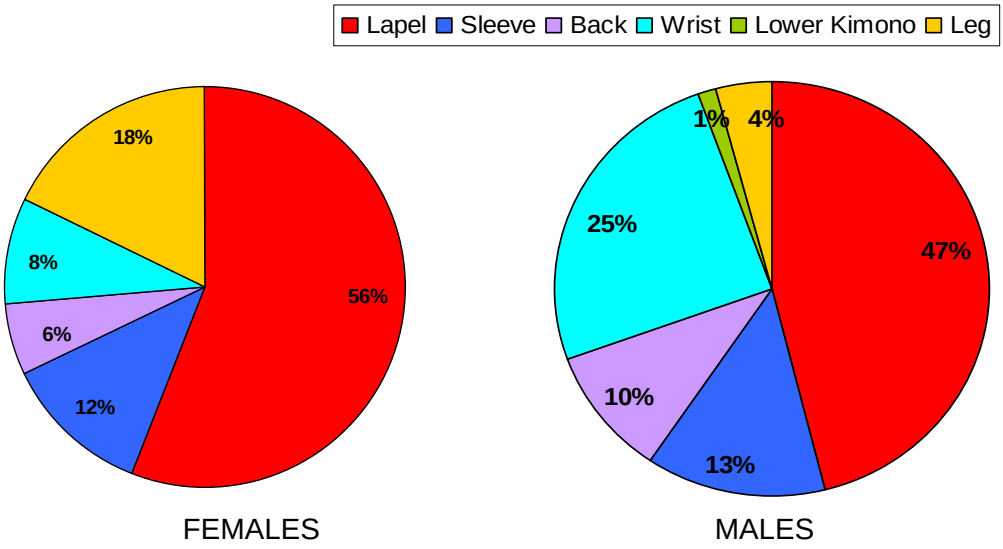

Fig. 32 Percentage comparison Females – Males first grip area

Q1	*3*
Min	*1*
Median	*5*
Max	*14*
Q3	*9*

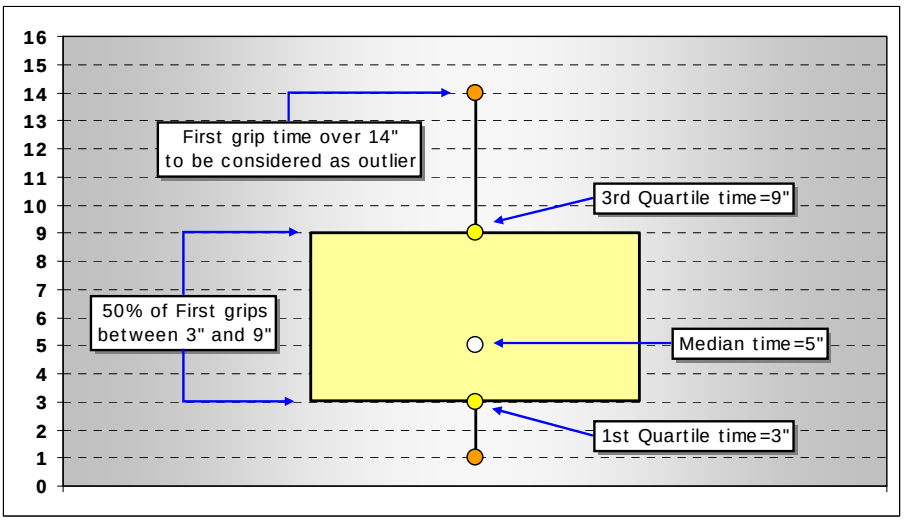
First grip time over 14" to be considered as outlier
3rd Quartile time=9"
50% of First grips between 3" and 9"
Median time=5"
1st Quartile time=3"

Fig.33 Indicators of time fight for the first grip in the 18 finals distribution (Box Plot)

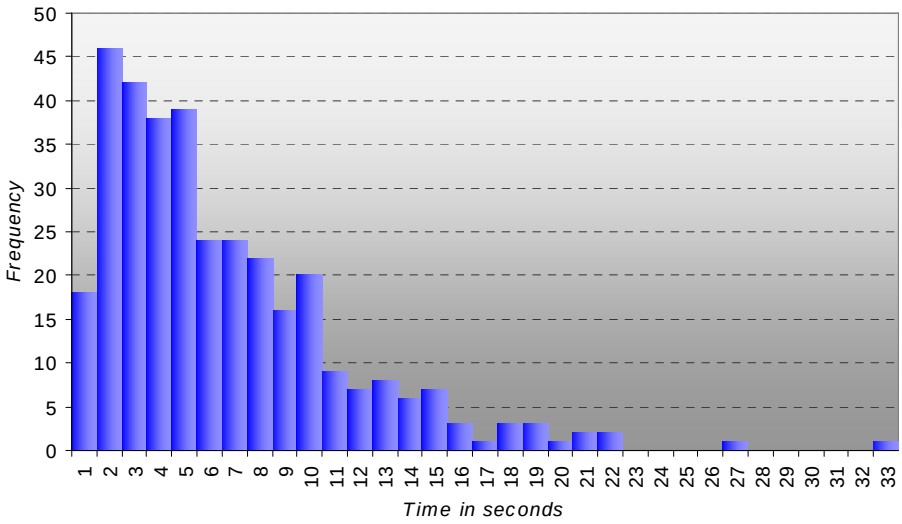

Fig.34 Frequency distribution of fighting time for the first grip in the 18 finals

Data analysis showed that the majority of first grips was on the lapel area, both for female and male. There are instead some differences considering other areas: the leg area is the second preferred by female while the wrist-hand area is for male.
To evaluate if there is a statistically significant difference considering the frequency distribution by grip area and gender, the authors conducted a chi-square test, rejecting the null hypotheses with a p-value of 0.0001.
For this reason it was possible to say that female and male have different behavior in choosing the first grip area.
Considering time distribution of the fighting phase for the first grip, 50% of first grips happen between 3 and 9 seconds with a median value of 5 seconds.
In the 18 analyzed Finals, were found 270 fighting phases for the first grip, with an average of 15 kumi kata phases for judo match.

5.7 Transitory Phase: Grips Fighting

Grip fighting is an important part in the today judo competition, part in which the muscular power is very important. Strength is used to battle or to prevent a grip; in the same time power against power, to impose a grip.
Competitor can 'impose' grip only when it is powerful enough so that the opponent cannot avoid or 'break' it.
In effect, the situation today is that grip fighting not only is important but also that it is used as a major strategy in modern competition.
Serious grip fight requires lots of power and energy.
It essentially could be defined a power-based arm-wrestling.
When an opponent uses the kumi-kata approach in such a way that it is not solely meant for him to apply a technique, and obviously the adversary must find one answer to that.
Athletes must strength train so that " increase " muscular power and gripping skill, and thus they can 'break adversary's grip, this is the normal classic answer to the grip fight situation. But as will see in the following, there is a more Judo suited to the right way to think about.
In the following figures there are shown some phases of modern grip fighting form national to Olypic Arena.

Fig35 Grip fighting

Fig36 Grip fighting

Fig37 Grip fighting

Fig38 Grip fighting

Fig39 Grip fighting

Fig40 Grip fighting

5.8 Starting Phase: First Contact "effective grips"

About standard Competition it is already acceptable a classic study (Weers) focalized to hand position and successive attack direction.
Remembering that the right approach to grips in competition is to consider the whole Couple of Athletes System., and the resultant "Competitive Invariants".
The following approach (1985) is due to Mr George Weers, former chairman of the United States Judo Association coaching program.
The analysis performed started as the players came to grips observing the first hand to make assertive controlling efforts.
Next the determination of the player's primary attacking direction was analyzed.
Of the 549 players observed 278 have right sided preparations while the remaining 271 were lefties.
In 164 of the episodes of gripping the players placed their Power Hand first; while 385 of the situations saw the players reaching in with the Locking Hand.
This gives us a statistic of 70.13% of the time elite players will grip first with the Locking Hand.

5.9 Stabilized Situation: Grip Domination

5.9.1 Effective grips and throws

Other research works connecting the hand positions (divided in Power Hand and Locking Hand) and throws direction were performed giving the following results:
“71.12% of throws to the Front Corners were accomplished with a Power Hand Placement on our near the clavicle.
22.99% of the throws to the Front Corners had Power Hand Placements on the High Back area, against or near the neck, of the opponent.
When we combine these two Power Placements for throws to the Front Corners we see that 94.11% of observed throws to the Forward Corners put throwing pressure, with the Power Hand, on or against the opponent's neck.
Body throws, are the types of throw where the attacker tightly controls the opponent's torso and turns both himself and the opponent to the mat. These throws are typically Ura Nage, Kosoto Gake or Sukui Nage.
The Body throws application presents an incredibly consistent Power Hand Placement with 91.3% of the Power Hands reaching across the opponent's Lower Back.
Some incidents of Body Throws had the Power Hand encircling the Near Leg from the Rear.
The remaining 8.7% of the Body Throws observed had a Frontal Power Hand Placement.
Throwing attacks to the opponent's Rear Corners, Osoto Gari, Kouchi Gari, etc., showed a slightly more diverse Power Hand Placement pattern.
In throws to Rear Corners, 33.33% of the Power Hand Placement was in the Mid-Front area of the opponent's torso. Generally, the Power Hand was placed against the pectoral region.
The majority of throws to the rear Corners, 66.62%, were performed with the attacker's Power Hand placed in the defender's High Back area. As a rule the Power Hand Placement, for these throws, tended to be toward the defender's shoulder or the outer top corner of the scapula.
Lateral throws, Driver type throws that push the defender over the side of his foot, showed the widest range of Power Hand Placement. 57.29% of the Power Hand Placements in Lateral Throws were in the Lower Back region. The Lower Back Power Hand Placement for Lateral Throws was distinctly different from the Lower Back Power Hand Placement for Body Throws.

5.9.2 Competitive patterns

High incidences of Kenka Yotsu (opposite stances) were observed by Weers in the previous cited work. He analyzes that if the players hold one another with opposing Power Hands (right versus left); allowing the opponent to place his Power Hand unopposed generally results in a neutral Ai Yotsu position, in which neither player is willing to take a chance on shifting his grips.
And Weers follow the analysis in such way: “the unwillingness to venture into other gripping strategies is probably due to a strong defensive position. With an arm glued into the armpit of the opponent the player is able to hold the attacker out on anything he might try.
Normally the best grip fighters tend to prepare an opening for the Power Hand placement.
The player will reach in with the non-Power hand, pull the lapel out for easier access, brush aside the opponent's hands or simply set a blind for the intended Power Hand placement and then take the Power Hand Grip.
The champions keep the Power Hand tucked in close to the side and move the whole Power Side of the Body in under the grip.

The attacker "sets" his Power Hand and then moves his whole body toward the Locking Hand position. Upon securing the Locking Hand a strong attack must be the inevitable final step of the sequence.
If Players took a mutual Power Hand without opposition matches were frequently without score, always boring and usually awarded to the stronger player; the higher the level of play, the higher the incidence of complete separation and re-gripping.
Apart from blocking any of the opponent's gripping advancements, grip dominant players are highly skilled at removing the opponent's hands. This leads to frequent complete separations of the players. Once the players are separated they are able to work back into a favorable gripping position.
Once the grips are secured the player attacks! If the grip is there the top player throws.
If the throw is not successful he breaks off and starts over".

Fig.41 Taking a Dominant Grip, instantly athlete must attack

IIIrd Part

Kumi Kata and Throws

in

High Level Competition

6. Grips Fighting?

A different way of thinking: timing and Sen No Sen during Grips fighting.

6.1 Timing

Time is in competition one important player.
Most important data are collected and analyzed into the time domain, to know, understand and forecast useful pattern in competitions.
In the next two tables there are shown the results of a recent analysis performed by Francini and co-workers. In which it is possible to know the time duration and percentage of some topic competition phases

Table 5: Analysis of sequence (time between *Hajime* and *Matte*) and *break* time regarding the main occurrences in judo matches (measured in seconds)			
	Match 1(s)	**Match 2 (s)**	**Match 3(s)**
Preparation	4 ± 1	4 ± 2	4 ± 1
Grip	16 ± 5	18 ± 3	17 ± 3
Technique	1.4 ± 0.3	1 ± 0.4	1.7 ± 0.5
Groundwork*	17 ± 12 (6 ± 4)	9 ± (4 ± 2)	13 ± 6 (5 ± 2)
Break	7 ± 1	6 ± 2	7 ± 1
* Values represent mean time and standard deviation for action on the ground, considering that not all match sequences have ground action. Values between parentheses are mean and standard deviation values in approximately 11 sequences, four of which are on the ground			

In both tables it is possible to see that the longest part of competition is connected to grip phase.
From this second table all people see that grips account around the 50% of the contest.

Table 6: Analysis of the percentage of each match sequence and *break* time of main occurrences in judo matches			
	match 1 (%)	**match 2 (%)**	**match 3 (%)**
Preparation	12 ± 4	13 ± 7	13 ± 3
Grip	49,5 ± 9	49 ± 10	49 ± 10
Technique	4 ± 1	3 ± 1	5 ± 2
Groundwork*	18 ± 13(7 ± 5)	11 ± 5 (4 ± 2)	14 ± 7 (5 ± 1)
Break	19 ± 3	16 ± 6	19 ± 3
* Values represent mean time and standard deviation for action on the ground, considering that not all match sequences have ground action. Values between parentheses are mean and standard deviation values in approximately 11 sequences, four of which are on the ground			

Then also as in time length during contest grips and grips fighting are an important part of the competition.
But if in throwing techniques attack the most sensible phase (and not only for Kodokan or Japanese people) is the application of sen o sen , the athlete must open mind and think in positive way, studying the application of sen no sen during grips fighting , the first normal application is during the first contact phase on timing.
From the biomechanical point of view when two athletes try to grip each other they take , normally three natural positions, two configuring with the adversary one type of "Competitive Invariant" in Ai-Yotsu (Right vs Right or Left vs Left) the other configuring with the adversary one type of "Competitive Invariant in Kenka-Yotsu (Right vs Left)

Fig.42 Ai-Yotsu Left-Left (see feet)

Fg.43 Ai-Yotsu Right –Right (see feet)

Fig.44 Kenka-Yotsu Right –Left (see feet)

It is easy to watch that each athlete who tries a right grip put naturally the right foot ahead and the left foot for the left grip.
However weight is normally placed for safety on the back foot, this position is biomechanically speaking a position of unstable equilibrium and it would be better for athletes applied to high performance competitions train him to take vantage from this phase, attacking on timing during these unstable conditions.
In the next two figures there are shown two wrong equilibrium situations for the white player that the blue one can use to attack before the stabilization of grips.
These phases are highly fast and transitory but they are also a territory almost unknown full of opportunities, for well trained, open mind Athletes.

Fig.45 White grips unbalancing his position

taking his grip white put himself in a dangerous situation that blue can use to attack.

Fig.46 White grips without controlling Uke counter

With this other position white give the opportunity to blue to attack (Seoi- Sasae, etc.) on his right side because the control of the right side of the blue is totally missing.
Classical is the habit of phase dissecting of gripping approach to competition.
In the following there is one example of such classical approach, step by step, in which every hand and arm movement is explained on timing for teaching use. Starting from one of the basic positions Ai-Yotsu, or Kenka-Yotsu, Fig.40, 41, 42;

Fig.47 One basic position before grip fight

Classical Teaching Field

Normally in the Dojo the coach or teacher uses indication step by step to teach the basic of the grip fight, explaining in an understandable way all the single movements connected to obtain the goal, like the following instructions.

I. Right Sided Players

Right vs. Right (Sequence #1)

1. Right foot forward with your left shoulder back (As a Left handed boxer would stand).
2. Always reach with the left hand first (you must get left hand on opponent's gi FIRST!).
3. Right arm bent (elbow down) and protect your neck.
4. When opponent reaches with right hand, grab their wrist with your right hand before they touch your gi.
5. Two on one (place both hands on his right arm), secure their sleeve with left hand
6. If opponent has your right sleeve, break their grip by making a clockwise circle with your thumb.
7. Grab their lapel or neck with your right hand.

Right vs. Right (Sequence #2) –
If your opponent takes your sleeve and is dominating the grip:

1. Left foot forward (right shoulder back).
2. Reach with left hand first (you must get your left hand on opponent first).
3. Keep right arm bent (elbow down) and protect your neck.
4. When opponent reaches with their right hand, grab their wrist with your right hand before they touch your gi.
5. Two on one (place both hands on her right arm), secure the sleeve with your left hand.
6. If your opponent has your right sleeve, break their grip by making a clockwise circle with your thumb.
7. Grab her lapel or neck with your right hand.

Key Points:

Forget what your opponent is doing with their left hand; focus on their right arm only. Keep your left arm straight, and always push against your opponent's shoulder to slow down their right hand (Do not push into your opponent: use the arm as a post). As your opponent reaches, turn your chin and shoulder away from your opponent. Never lunge to get a grip.
Make a circle with thumb clockwise and bring it to your chest to break their grip

Right vs. Right (Sequence #3)

– If you cannot stop your opponent from getting your neck or cannot get your left hand on the gi:

1. Right foot forward and your left shoulder back) As a Left handed boxer would stand
2. Cross grip their lapel with your right hand to get a grip.
3. Feed right lapel with your right hand to your left hand.
4. Grip as described in sequence #1 above If opponent reaches before you can get her lapel, stop her right hand from grabbing by raising your left hand to catch your opponent's right arm.

Key Points:

Be sure to push (post/hold) on your opponent's shoulder with the cross grip.

II. Left-Sided Players

Left vs. Right Gripping:

1. Basic Concepts

a. Inside control – set lapel hand, and then reach for the sleeve.
b. If power gripping, pull opponent in (not keeping them at an arm's distance).
c. Note: Keep your head on the outside of their body.

2. Advanced gripping

a. Cross grip the lapel then get the sleeve.
b. Sleeve cross grip series

Note: Never push when gripping.
Posture must be set before grabbing with two hands. You must change your gripping sequence all the time during a match.

Additional: It is important to show grip fighting and what it should look like in practice or training. Always pair right handed players with right handed players, and left handed players with left handed players. We also train gripping via line-ups, so that the stamina in hands is improved and gripping

6.2 A deeper Grip Concept

A well known sentence give the most classical information about grips**: …** ***without a grip in Judo you will not be able to throw. This is easily demonstrated, try and throw someone with no grip at all, then with one hand on your opponent, then with two hands....***
This very sound "Common Sense" give us the right direction to truth.... but the not conventional "Biomechanical Sense" shows us different "deeper" path to truth.
In fact, to do that, it is essential to deep in the biomechanics of throwing techniques concept.
Couple Group
If we analyze the Techniques of "Couple of Forces" Group, ***General Action Invariant,*** as basic shortening movements of distance into the couple of athletes system, are directly connected to Tsukuri, Kake Phases and the fantastic information is that, in this case, Kuzushi is not a necessary and sufficient condition, and it could be non present in some couple techniques agonistic applications.

Fig 48,49 General Action Invariant flowing in Kake phase without Kuzushi (Okuri Ashi Harai);

This means that in such group there are necessarily only Tsukuri-Kake phases, in fact the presence of Kuzushi helps obviously the throws but it is not absolutely necessary, because **for Uke in unstable equilibrium, the rotation around his COM is helped by the external gravity force.**
The other valid information singled out is that, these more simple techniques, biomechanically speaking, can be applied in competition whatever shifting velocity the couple of athletes could have. The couple techniques are connected to their Japanese denomination considering the Tori three body's symmetry planes in which lie the couple of forces.

Sagittal Symmetry Plane Application of
1st ***General Action Invariants***: O Soto Gari, reverse direction Mae Ushiro Uchi Mata,
2nd ***General Action Invariants:*** Harai Goshi inverse application Ushiro Hiza Ura Nage,
3nd ***General Action Invariants:*** Uchi Mata, inverse (Back) Ushiro Uchi Mata

Transverse Symmetry Plane Application of:
3nd ***General Action Invariants:*** O Uchi Gari, Ko Uchi Gari (There are not inverse but opposite from the other side)

Frontal Symmetry Plane Application of:
1st ***General Action Invariants:*** Okuri Ashi Harai; opposite Okuri Ashi Harai from the left side,
3nd ***General Action Invariants:*** Ko Soto Gari opposite Ko Soto Gari left side

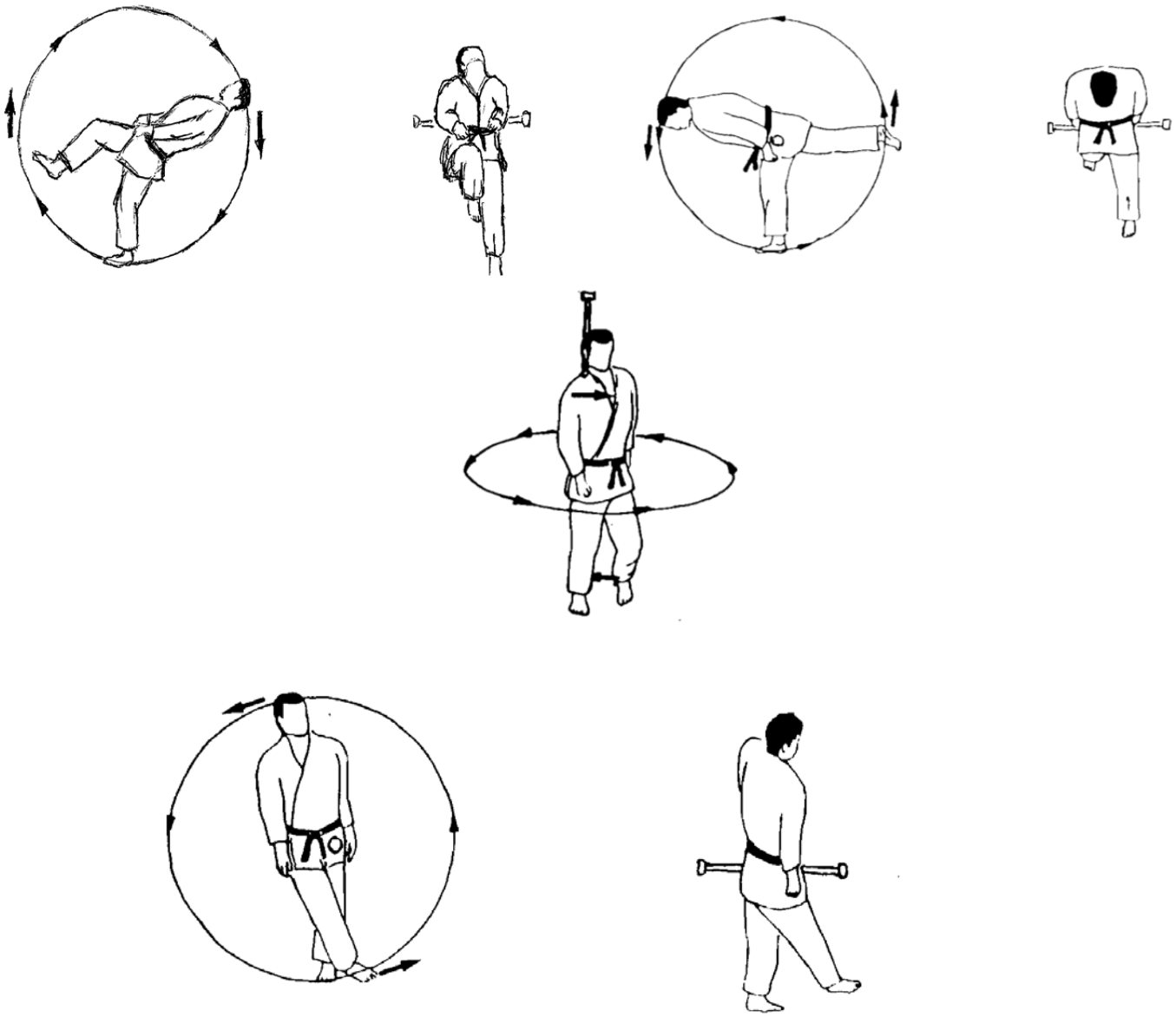

Fig50-53. Application of Couple in the three planes of Body symmetry: Basic Movements A) Sagittal, B) Transverse C) Frontal

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But the extension can be more wide, to understand how not necessary is the kuzushi phase in this group, in still position, for teaching goal**, it is possible to throw someone by de Ashi Barai and by Uchi Mata for example without grips.** (Out the common sense!)

Lever Group

In general considering the degrees of freedom connected to the superior kinetic chains, related to body movement, it is easily understood that all the potential movement in the ***Specific Action Invariants,*** for the superior chain, in the Kuzushi actions are connected to the three degree of freedoms of the Achromium Joint (shoulder).

From the other side the most important part of the inferior actions are in charge of two Joints hip and knee, less part to the system foot/ankle (the first for setting better his ones' body in relation to Uke' s body, and the second ones to applying only fulcrum in the lever).

Another important notation is that both ***Specific Action Invariants***, must be connected each other in one harmonic way to produce the right and effective throw result.

Kake phase, for the techniques of physical lever, is the result of the well interconnected work performed by both kinetic chains in different time steps: at first the superior chain open space for the body in the adversary grips, then the ***General Action*** (distance shortening) is developed followed harmonically by the connected work of both ***Inferior*** and ***Superior Action Invariants*** through the abdominals and trunk muscles.

These techniques need more skill in harmonic chains connected movements, than couple techniques; in fact often they are ineffective because lack in harmony into one of the previous movements is able to stop the throwing result.

The same ***General Action Invariant*** (**full rotation**) that (considering only the inferior chains) splits by three ***Inferior chain action invariants*** from up to down, into three well known techniques Seoi nage standing , Seoi Otoshi and Suwari Seoi.

All these Kuzushi-Tsukuri movements flow in the Kake phase of physical lever application with variable arm, from the most energy wasting one to the lesser ones.(See fig. 54,55)

Fig 54,55 Inferior Chain Action Invariant (Seoi); Inferior Chain Action Invariant (Seoi Otoshi) (Finch);

The same ***General Action Invariant*** (**direct shortening without rotation)**, that (considering only the inferior chains) splits by three ***Inferior chain action invariants*** from down to up, into three well known techniques , Sasae Tsurikomi Ashi, Hiza Guruma, and Tomoe Nage.

If someone looks at the inferior kinetic chain only leg and foot of Tori go up from the ankle, to knee, to Uke's abdomen. All these Tsukuri movements flow in the Kake phase of physical lever application with variable arm, from the less energy wasting one to the most expensive ones.

The same ***General Action Invariant*** (**full rotation**) that (considering only the inferior chains) from down to up, splits by three ***Inferior chain action invariants*** into three well known classic techniques Tai Otoshi, Ashi Guruma and O Guruma.

If someone looks at the inferior kinetic chain only leg and foot of Tori go up from the Uke's ankle, to knee, to Uke's abdomen. All these Tsukuri movements flow in the Kake phase of physical lever application with variable arm, from the less energy wasting one to the most expensive ones.
In the next figures there are shown some inferior chain action invariants connected to Sode Tsurikomi Goshi

Fig 56,57 Inferior Chain Action Invariant for innovative Sode Tsurikomigoshi;(Finch)

Among the lever group techniques there is a Maximum harm subgroup in which the ***Superior chain Action Invariants*** play the most important role there are techniques like: Uki Otoshi or Sumi Otoshi in which there is no body contact at all, but the fulcrum, under Uke feet, is made by the friction between mat and foot .In the next figures we can see the main use of the ***Superior chain Action Invariants*** (generally this class is responsible of forces application) and in this way it is possible to define the main useful angles for **Kuzushi that is essential in these kind of techniques**, because as it is easy to understand it is not possible to apply a physical lever principle, without the application of force far from the fulcrum.
Not only, but the presence of the connected movements makes this techniques biomechanically speaking more complex, and on the basis of the physical principle for their useful application in competition whatever shifting velocity the couple of athletes has, they need of a stopping time (also very short) to be applied.
If Kuzushi is essential our grips are essential (Common sense) help us.
But if we speak in term of Biomechanics it is interesting, remembering the Galilean relativity and to think that grips are a "complementary" approach to interaction.
This means that contact, connecting the two bodies in one whole unit, is essential to apply throwing forces, but **connection** could be accomplished not only by two, but also by one side only.
In other terms, the first things that grips do is to connect two athletes in a Couple System, and if somebody grips the opponent and the opponents does not grip him, then they are in any way connected in one Couple of Athletes System.
Connection is assured by contact point, not only by our hands but also by opponent's hands alone
Then from this point of view **: if grip is accomplished by opponent's one hand, the two bodies are "in such way" connected, and for the athlete connected without taking grip it is possible, utilizing the opponent's connection (Sen No Sen) strengthened by his two hands on the gripping arm, (** *if the grip is not strengthened opponent could open hand and solve connection* **) to apply a throwing techniques using his own body's weight (internal Tai Sabaki lowering the centre of mass) as unbalancing and throwing force in the direction of gripping arm.**

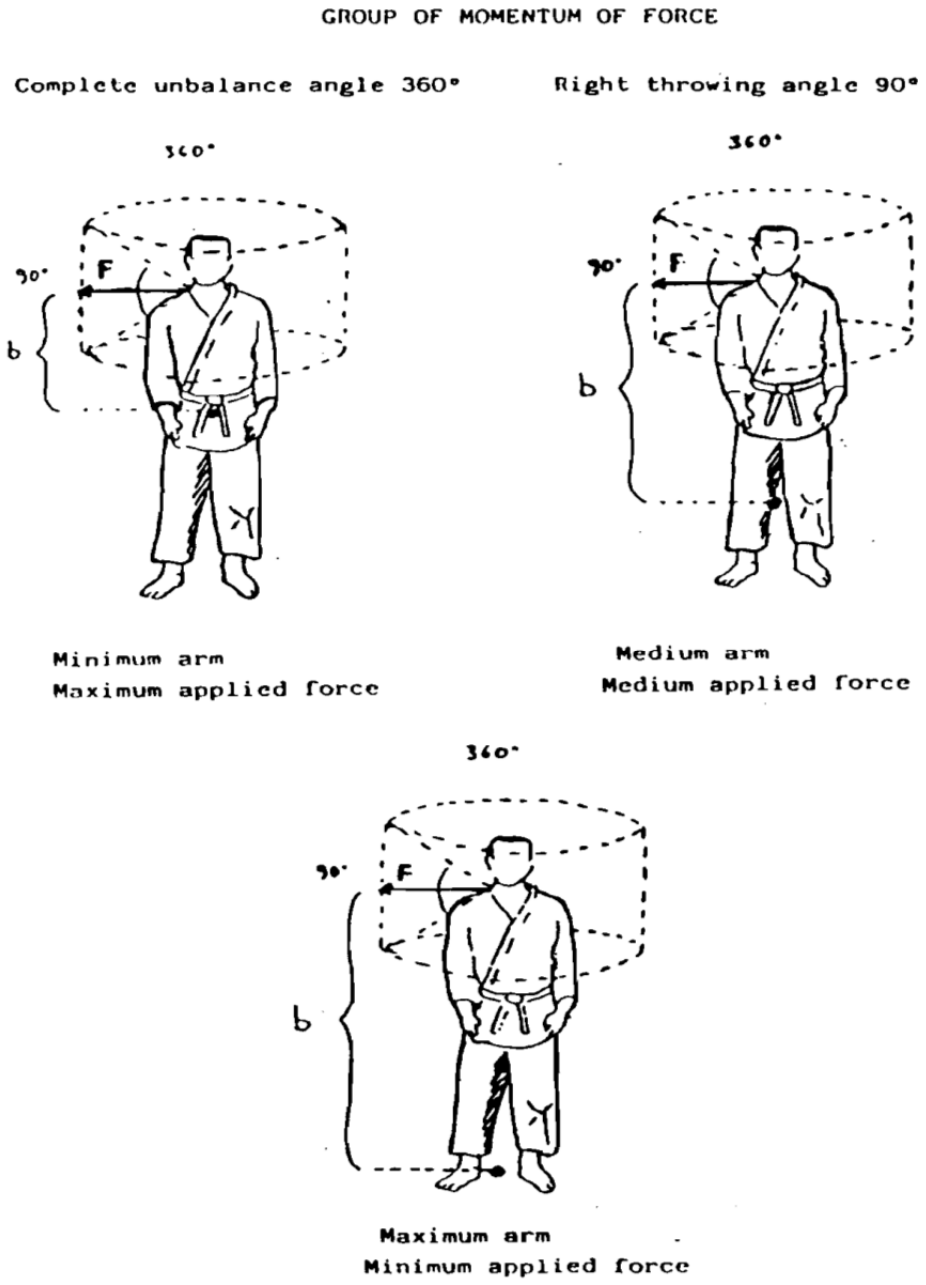


Fig 59 Complete and right angles to unbalance and throw Uke with physical lever.

Sacripanti A, *Biomeccanica del Judo , ed Mediterranee Roma 1988 ISBN: 8827203486 9788827203484 Advances in Judo Biomechanics research VDM* Verlag 2010 *ISBN* -10: 3639105478 **-***ISBN*-13**:** 978-3639105476

6.3 Timing: application of "JU" Principle during grip fight.

From the semantic point of view "Grip fighting", is essentially against the judo basic application. Power is used to battle a grip, power against power, or power to impose a grip.
The basic idea of judo is flexibility and not hard power; the idea is that technical opportunities are sought through action/reaction using the adversary's force (push/pull).
The situation today is that grip fighting is used as a major strategy.
Serious grip fight requires lots of power and energy. It aims to prevent inferior position, or it aims to ... 'impose' fighting taking a vantage position. 'Imposing' your fighting has nothing to do with "JU" principle. 'Impose' fighting is essentially, as already said, a power-based arm -wrestling.
Nevertheless, for judo itself to still be effective against such a person who refuses ju-based judo, likely in an attempt to avoid being thrown, rather than wanting to throw opponent in a contest, an athlete must realize the complete domination of the adversary.
When an opponent uses his Kumi-Kata in such a way that it is not solely meant for him to apply a technique, but for him put opponent into an inferior psychological situation, then adversary must find the answer to that. And, to do that, there are two ways:

1) the strength training that " increases " force, and thus in such way it is possible to "impose" or 'break' the opponent's grip,
2) to apply "JU" Principle by means a right movements like a Tai-Sabaki that avoids and prevents the situation. The effectiveness of Tai-Sabaki does depend on the athlete skill,

The major challenges for the athlete using Tai-Sabaki will be speed and agility.
Continuous high-speed Tai-Sabaki would drain athlete's energy, in effect they use a rotator jumping shortcut, instead of the classic Tai-Sabaki, this increases speed but drains energy; however with a right training each athlete would be able to apply such "forgotten" or "misused" JU principle.

6.4 Sen No Sen on grips

***A) Two step: break and attack (*Didactic not effective)**
Sen no sen to grips attempt is the right application of judo soul in competition, it is essential to fight at any occasion and also the first phase of a judo fight could be occasion to take vantage over the opponent in this high transitory phase. Normally in such phase the most applied system is "break the grip and instantly attack" Really more often it not works in real competition but is useful for teaching. See sequences

Fig 60 Example of Sen No Sen on grips (break and attack)

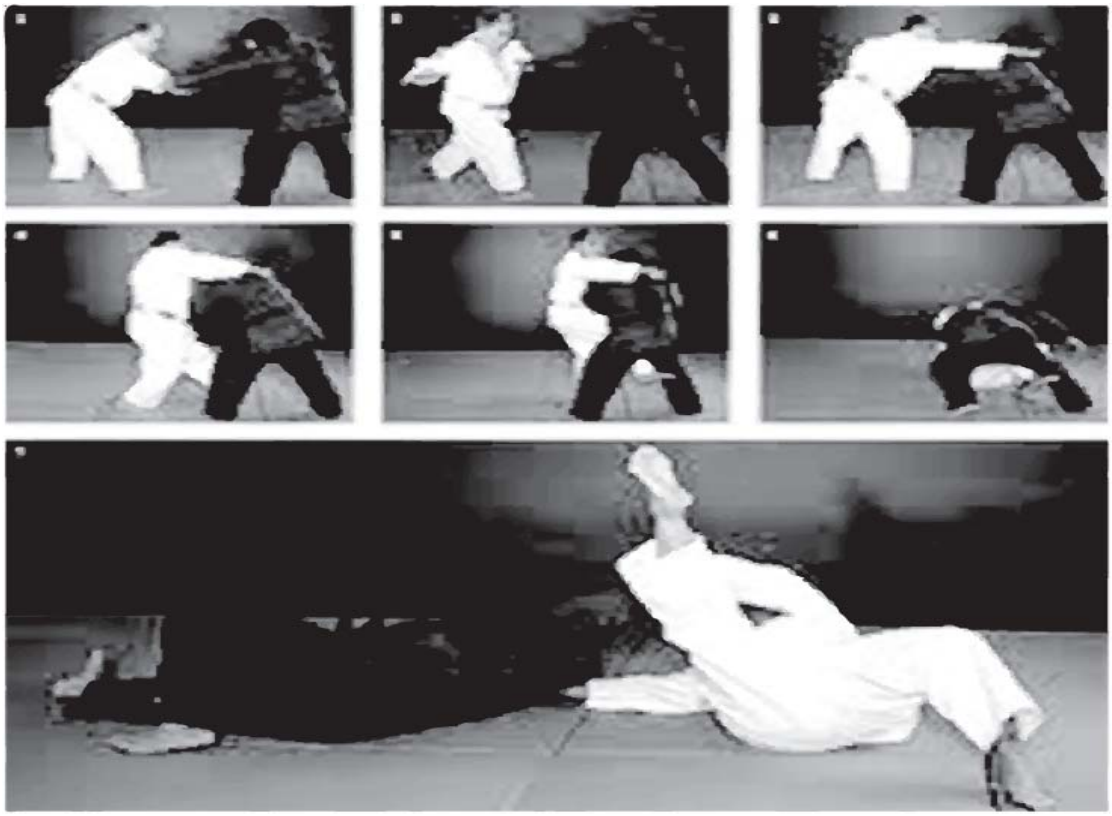


Fig 61 Example of Sen No Sen on grips (break and attack)

***B) One step (*highly effective)**

(Uke first grips ,Tori stabilizes the grip by two hands on the gripping arm and simultaneously turns lowering the COM and apply the technique).

It could be a more subtle way to apply Sen No Sen in such situation.
To throw without grip, using the opponent's grip that let him to stay connected.
Very clever expert of this approach was Won Hee Lee from Korea who applied this method many times.
Lee, timing, makes the right space with internal Tai Sabaki (**General Action Invariant** based on Hando No Kuzushi), stabilizes his contact, using the well known: two hands against one arm grip to strengthen the connection, and throws the opponents in harmony with the two hands contact as shown in the next Sequences.
It is not matter of techniques everybody can apply his preferred technique in the specific situation.
The internal Tai Sabaki more often follows the opponents pull, and with it athlete shortens the distance and set his body for throwing action, if athlete performs external Tai Sabaki, he avoids opponents action (wasting some time) and can apply some couple group throws like Innovative Uchi Mata. Avoiding and Sen No Sen form strategies, depend also from weight and personal speed and skill of athletes.
An opportune and ad hoc training of these situations would be useful to apply, carefully, such "Trick" biomechanically grounded both on the Galilean Relativity and a better understanding of grip concept in real competition.

Fig 62-64 White grips straight left hand, Lee Attacks two against one hand left Tai Otoshi

Fig 65-67 White grips right from top, Lee attacks two against one hand right Suwari Seoi

Fig.68-70 Blue grips right Lee's left side, Lee attacks two against one hand right Tai Otoshi

7 High level Judo Competition

7.1 (Breaking symmetry) right unbalance concept

All judo teacher and coaches are accustomed with the well-known concept of Kuzushi the brilliant idea that Dr. Kano Introduced in his Judo.
But there is a long conceptual distance between the theoretical explication (Happo no Kuzushi) and the practical application in competition!
Normally during competition it is not possible easily to apply the theoretical Kuzushi concept, for many reasons, the most obvious one is the resistance produced by the adversary.
The theoretical explication by Kano was borrowed by the rigid body analysis from physics, but a short thinking shows us that human body is not rigid but articulated, and Biomechanics persuades us that the Body's Center of Mass moves is position both inside and outside the body , changing the stability situation also without totally unbalance the body.
Normally we are used to consider balance position in standing right situation, that is a position of unstable equilibrium, if the athlete is still the Center Of Mass (COM) is more or less under the navel in the origin of Athlete's reference system, connected to the well-known three symmetry planes of body (frontal, sagittal and transverse).
If the adversary's body is rigid, you can easily apply the Kano unbalance concept, but if the upper part of the body turns or bends on the side, you can't apply it.
However in these last previous cases COM shifts and changes his position and both stability and mobility of the body are changed.
And with a perfect timing it is possible to profit of these transitory situations; this is the right and useful application of unbalance concept in competition.
Remembering that human body is not a rigid system but an articulated one's, we can understand the subtle application of the so called: breaking symmetry.
Such actions like bending or turning are easier to apply; increasing stability, they produce a decrease in mobility that is generated by the shifting of COM inside the body but sometime outside.
Normally it is easier to induce the adversary to bend or turn, during grips fighting, because there is not knowledge about breaking symmetry.
Breaking Symmetry changes the body's stability and slows down the adversary shifting capability, in such way it makes easier the application of throws.
This is the first part of the "advanced kuzushi" concept, meaning: before slowing down with a breaking of symmetry and after, with a body collision ends the effective kuzushi phase.
Normally body movements of both athletes increase the unbalance situation helping the throwing action, the right use of these situation, are called by Japaanese Masters hando no kuzushi.

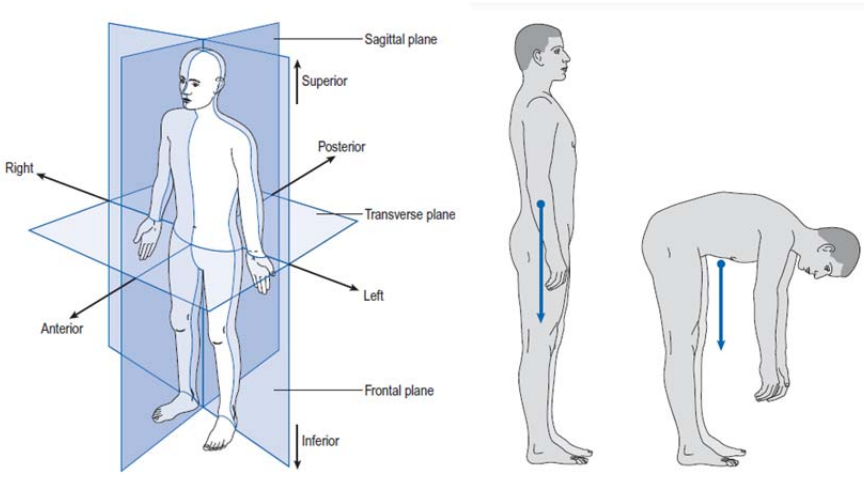


Fig 71 ,72 Human body's Symmetry plane, COM in and out;.

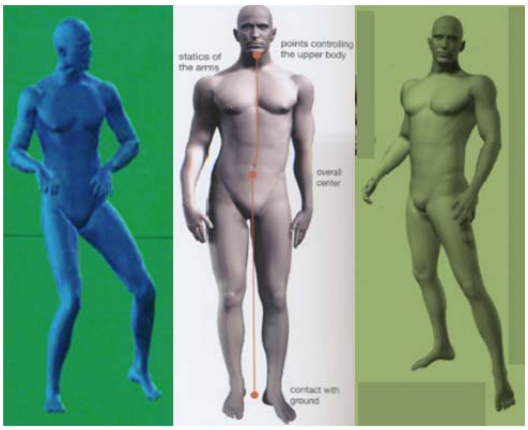


Fig 73, 75 Simple symmetry breaks that shifts the COM inside the body, slowing down the body.

Fig 76-79 Examples of symmetry breaks in competition

Many people don't know this advanced unbalance concept and mistakes breaking his own symmetry helping the adversary in his throwing action.
From that it is easy to understand that athletes for high level competition must work a lot around the study on symmetry breaking: how to produce it, and how to use it in useful way.
This is a original branch of analysis, full of new interesting discoveries, that high level competition coaches must develop to give more useful and up dated tools to their athletes.

Then we can assess the basic biomechanics steps of judo attack in High Level Competition:

- **First: breaking the Symmetry to slow down the adversary (starting the unbalance action)**
- **Second: fast "General Action Invariant" application, with simultaneous overcoming of the adversary's defensive grips,**
- **Third: sharp collision of bodies (end of unbalance action)**
- **Fourth:**
    - **A. Simultaneous application of "Couple of Forces" tool without any need of further unbalance action,**
    - **B. Use of the appropriate "Specific Action Invariants", stopping the adversary for a while, needing to increase unbalance action to apply the "Lever" tool in Classic or Innovative or Chaotic way.**

The previous steps are the simplest movements' connection usually used to throws the adversary, but very often, more complex situations can arise in real fighting conditions, these complex evolutions of the simple steps previously explained, depend from the combination of attack and defensive skills of both athletes.
One other important parameter in high level competition is athletes' body weight, the previous speeches are connected to fast shifting mobility and high speed application, but these capabilities are, very often, inverse proportional to body weight.
The fighting style changes with body weight and the general lack in fast shifting capability, the well-known slow pace of heavyweights detains the sen-no sen application on grips, in this class of athletes..
Often heavy and super-heavyweight athletes prefer, some Koshi waza and Ashi Waza, in Makikomi evolution, all applied both in Classic and Innovative form, normally the fighting pace is slow ans also the attack speed is not so fast, however Yamashita, Douillet and Riner are astounding examples of exception to this general description.
Finally "Champions" could be considered all athletes able to master these continuous changing situations, instantly.
These steps born by the biomechanical analysis, are not new but normally applied by high competition Champions by instinct, without consciousness, and this is the first time that they are assessed and explained in clear way.
The previous analysis clears the right way to throws in high level competition, from the biomechanical point of view.
This is the reason to deepen the right use of the breaking symmetry tool in high level competition , his knowledge helps to drive and simplify the throwing phase with a subtler knowledge of the classic Kano's unbalance concept.

7.2 New concept of time and space

Another very important goal of athletes is to shorten attack time; this obviously goes through two main directions:
The attack speed increase with some special conditioning exercises, but it is very difficult to increase adult speed both in simple or complex movement, because speed is a genetic properties of the Athletes, normally at maximum it is possible only a very little increase in such ontogenetic quality, which is developed during 8 and 14 years of age.
But time of attack can be shorten not only by speed increase (practically impossible in adulthood) but also, by biomechanics tools, remembering that velocity is Space covered in Time $v = \frac{ds}{dt}$ then it is possible to increase velocity shortening the space covered, in plain words, the solution can be obtained, by a sophisticated study of contact trajectories, that can be shorten with proper and well timed movements, with the use of ***Hando No Kuzushi***, which is based on the biomechanical principles of action and reaction.
Normally player uses the so called, "proof" (action, motion or push/pull) to produce a reactionary breaking of balance.
It is the clearest application of the Judo principle "Maximum efficacy with minimum effort", using this principle, player applies force to the opponent and when he feels the typical movement response or resistance, he can take vantage reversing his movement into the right direction.
By ***Hando No Kuzushi*** every action or reaction of the adversary can be turned against him shortening contact time.
The capability to manage rightly the bodies' relative position is essential in the execution of a specific motor skill, like a throwing in non conventional relative position produced by competitor reaction (Hando No Kuzushi).
Normally today moving space is shorter, and more often there is short distance between heads and more distance between bodies (see Competition Invariants). That produces new way to turn and contact the opponent's body, based on speed and maximum trunk-leg flexibility.
Another sharp way used in high competition is: by his owns weight or special grips increase the stability of opponents, slowing down their shifting velocity before attack, reproducing sometime positions studied during Dojo technical training. In the following three figures it is possible to see a modern and right way to manage timing and short space in Competition.

Fig.80 Managing space , breaking symmetry (Hando No Kuzushi)

Fig.81 Managing time and GAI application (Hando No Kuzushi)

Fig.82 Modern Management of space and time: Application of Lever tool. Innovation in Throws

Fast Intuition, speed, decision and precision are the main tools to achieve this goal, but the most important for athletes in this field is: his Open Mind, or the capability to think in non conventional way to solve the competition problems faster and safer.
See for example in the previous figures: the original position of grip and the innovative throwing technique flowing from them; the previous considerations, open new way to rethink time and space concepts in original way.

The new concept of time and space must be connected to the effectiveness, but not only in ordinary way (shortening) but also in "irrational" not conventional way.
For example the two hands on one arm is a different "irrational" way to manage the distance between opponents, open space and turning.
However if the important is to achieve the goal : "Effectiveness", this goal could be achieved by more different way and not only shortening time and distance but also, for example, lengthening these two parameters if , this action , is useful to achieve the goal.
This means that in High level competition the most important tools are: open mind, flexibility, thinking originality that connected to high level skill and good physical and technical preparation that make Athletes able to catch the "Champion" level.

7.2 High level effective judo based on irrational solution

In classical biomechanics the throws that teacher explains are called "Sportive Rational techniques", these techniques are worldwide known as Kodokan Go kyo Throwimg techniques.
These techniques are normally applied in every competition from club to the Olympic arena.
But more often they are applied effectively when there is a technical skill difference between opponents.
The capability to apply these techniques is grounded into the ability to ménage the time and space classical concepts..
Manage the distance in the Couple of Athletes system is an advanced skill at level of European Championship, but when opponents reach to the award zone, the skill differences become very little, and the dominion of space and time are normal capability.
Then the fights solution would be logically draw or win in presence of one eventual mistake.
Then how solve this equalitarian knowledge? With the only logical solution: application of irrational solution, based on innovative techniques or "strange" techniques called chaotic form, which constitution will be analyzed in the next paragraphs

7.3 High Speed, attack velocity, fast resistive reaction

7.3.1 Speed or Shifting Velocity.

The "Couple of Athletes" shifting velocity on the Tatami is the speed of the system, seen as a whole. There is important, because at every velocity class (low, average, and high) it will be possible to apply only some specific standing techniques.
And then it should be possible to manage a specific competition strategy.
The traditional Japanese grips are the so called classical grips: sleeve/ lapel; it is important that Russian style uses to acquire superior position, trays to bend forward the adversary to increase his instability and to slow down the shifting velocity
The same is obtained in Japanese stile , but in other way, by the right use of his own body's weight, in fact Japanese people is specialized to apply by classical grips his own weight on the adversary's body. In such way people speed is slackened by this specific sided use of grips.
Then in high level competition grips are connected also to slowing down the opponent, in such way, athletes try to apply techniques in almost still position.
If we think that every competitor has his own preferred pace of shifting velocity, depending from his own Tokui Waza, therefore to compel him at another disliked shifting velocity, it will cause to him a big technical-psychological trouble
At high level competition, the change in pace, is one weapon not very often utilized but very interesting and powerful to put the opponent in trouble, the only problem in applying this weapon is that athlete needs a long and careful endurance training finalized to the specific adversary.

7.3.2 *Attack Speed against Fast Resistive Reaction.*

The attack speed, to be tactically effective, must be, as higher as possible.
This speed is a physical-technical athletes' capability, specific for each athlete but for everyone is a capability able to be trained.
It is essential to remember that increasing in attack speed; it must not be to the detriment of precision of technical gesture which should be very flexible to fit the infinite and possible fight situations. Then there is advisable before to increase the attack speed and after to better the precision, with the growing of his own technical maturity.
Judo, attack speed is certainly, in most of cases, shifting velocity independent.
But at high shifting velocity of "Couple", fast attacking is connected on high "coordinative" skill.
For each athlete the increase of attack speed over his own personal maximum is very complex or practically impossible.
But attack speed increasing is a weapon too important to achieve for competition and if there is a physiological limit, however it is important to overcome it by different (biomechanical) tools.
In fact there are some very effective biomechanical tools, to prevent the fast resistive reaction of competitor, increasing attack speed by means of:
A) Decreasing of "*attack steps*" and **B) Decreasing of attack "*time or logical path* "** :
for example A) three Steps Attack → two Steps Attack ;
for example B) Sen No Sen on Grips (6.4) ; by both such ways it is possible to prevent activation of competitor *Reaction Capability*.
Also changing the logical path to shorten the distance, with some irrational and not so clear path, in such way it is possible to mislead the attention of the opponent, making useless his high fast resistive reaction capability.

7.4 Innovative throws same basic biomechanical principles different grip

Today many coaches speak about new throws, but in what can we find diversity in judo throws?
From the Biomechanical point of view to speak about "new" is only a senseless exercise, and more funny is to try to classify in whatever way these so called new techniques.
A more deep look shows us the real meaning of " new " in judo throwing techniques , perhaps it is better to speaks about innovation a more correct even to speaks about "variation" of the basic techniques.
In every judo throws, the Biomechanical basic principle is invariant, then all "innovative variations" will belong to the two classes of the biomechanical classification of judo throwing.

1. Physical Lever
2. Couple of forces

The tool is the same :Couple or Lever, and the innovation is founded only in one different grip application, which can, some time, identify in a different line of applied kuzushi forces.
Another way is also to use not only different grips but also different stopping point (fulcrum) with legs or body these techniques look strange at seeing and are called Chaotic".
An objective analysis of high level competition shows us that many times, with the actual high standard of fitness, capability and "judo knowledge" it is more and more difficult to apply classical techniques, if there is not a sufficient judo skill difference, between athletes.
If the difference is lesser, more often, the application of rational standard techniques is not sufficient or useful, and the victory is for people applying non rational solution to fight.

7.5 “Innovative” and “Chaotic Form” of throws

Before to define” Innovative Form” and “Chaotic Form” techniques in Judo it is important to think that from many countries there are new technical contribution to Judo Kodokan.
The will in victory and the ability to overcome opponents, is the root of this evolution (we don’t speak in positive or negative term we use evolution as meaning changing in time).
Some example of these new entries are the Korean Seoi Nage, the Cuban Sode Tsuri, the Korean Sukui Nage, the Russian Gyaku Uchi Mata by Chochosvili or the Khabarelli the last was a well known “free wrestling” techniques as demonstrated in “Advances of judo biomechanics research Muller Publ. 20102”, the armbar by Neil Adams to name a few.
These techniques can’t be found in normal judo Books; the main analyst of this phenomenon is Roy Inman from England.
This kind of new variation enables their users to catch opponent off-guard with throws to which no clear defenses have yet been developed, in all countries around the world.
In the following figures there are few examples from Russia and Cuba:

Fig 83-87 Cuban Sode Tsuri with one sleeve grip.

Fig 88-90 Russian Gyaku Uchi Mata by Chochosvili (Finch)

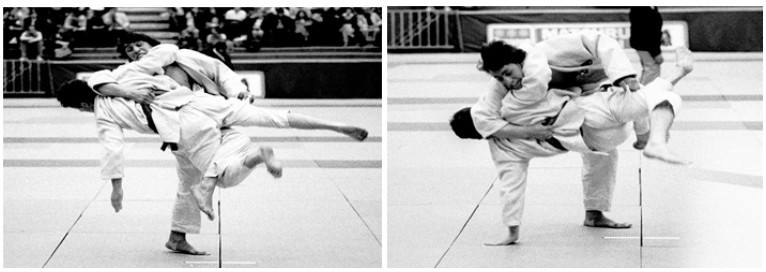


Fig.91-92 Khabarelli Throws (Finch)

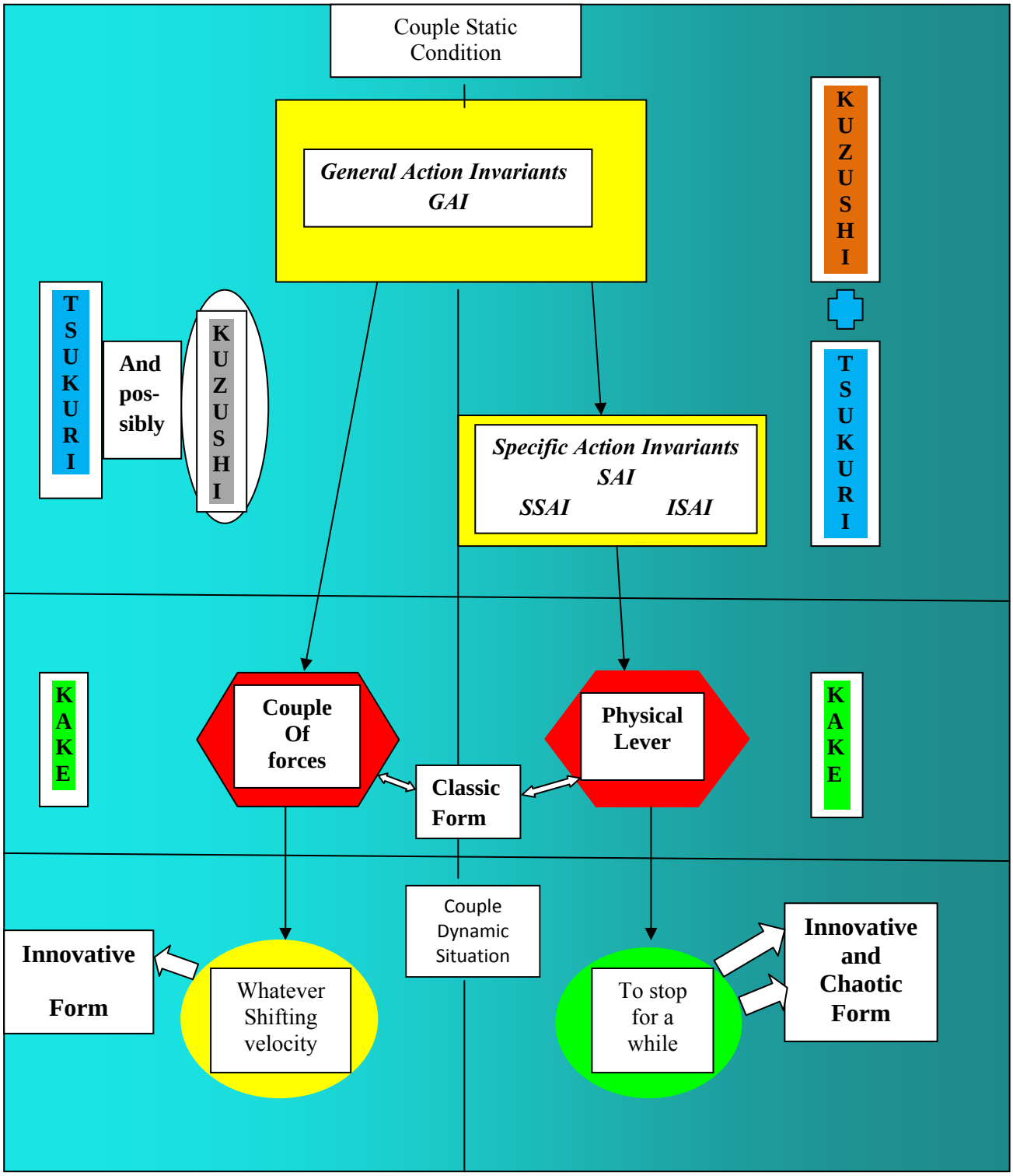
From the biomechanical point of view, it is important to define and understand how such techniques could bear.
Then it is possible to define, in term of biomechanical analysis:

Innovative Form are grounded on the same biomechanical tools and differ only for grips position. Then, in our definition, ***Innovative throws*** are kuzure application of classical Kodokan Couple and Lever techniques, and in them it would be easy to understand the basic traditional technique.
Other non rational solution, better defined "***Chaotic Form***" of throwing applied in competition is limited only to the class of Lever Group.
In the comparative biomechanical analysis of the Kuzushi (Unbalance) –Tsukuri (the entry and proper fitting of Tori's body into the position taken just before throwing) phases, already performed it was shown the existence of two classes of ***Action Invariants*** (**AI**).
Obviously the Kuzushi-Tsukuri phases are blended and connected in a whole movement, but for analysing them, it is better to separate them in two steps Kuzushi and Tsukuri. Now applying the biomechanical analysis to the Tsukuri phase, it is possible to group these almost infinite complex movements able both to shorten the distance between athletes, and to acquire the right body's posture to throw, in two general classes.
One consistent in some general simple body movements called ***General Action Invariants (GAI)***: these movements related to the distance shortening between athletes, analyzed as Tori's body movements, are only three:
General Invariants in Kuzushi-Tsukuri phase

1° Distance shortening without rotation.
2nd Distance shortening by a complete rotation clockwise/counter-clockwise (0°to180°).
3rd Distance shortening by half rotation clockwise/counter-clockwise (0° to 90°).

Now it is interesting that appears the real difference between the goals of Kuzushi- Tsukuri, in fact the Kake phase of Couple of Force doesn't need any refinement movement; instead the Physical Lever Group needs the addition of some specific movements of refinements depending by the right positioning action of both kinetic chains. This is the main difference between techniques that flow into Kake by Couple or Lever Groups.
All the techniques applying the Physical Lever must be refined by means of so called ***Specific Action Invariants (SAI)*** that are common to each class of these throws related both to the effective positioning of kinetics chains and the way to apply forces to unbalance Uke before throwing.
The ***Specific Action Invariants*** (**SAI**) are infinitive in number and connected to the superior and inferior kinetic chains motion and right positioning connected both to Kuzushi and Tsukuri phases.
Some interesting findings derive from this analysis:
Among throwing techniques, Couple Techniques could be independent from Kuzushi; instead Physical Lever Groups need all two action invariants to be performed successfully and as complex motor skill they are more difficult to perform than the first ones.
From these evaluation it is easy to understand that Innovations are possible both in the Lever and Couple groups, because in both groups it is possible apply variation of grips applying forces in different but right directions. Then both in the Lever and Couple Groups ***Innovation*** is connected to different use of ***Superior Specific Action invariant (SSAI)*** not only, but in Lever group innovation could be also connected to a different collocation of ***Inferior Specific Action Invariant*** (***ISAI***)
Because Couple Group is technically easier (***GAI + Kake***) in this group only ***Innovations*** are possible, based on the stereotyped Tori Body's movement that is responsible for Kake action.
Only the Lever Group, which is built in more complex way ***[GAI + (SSAI + ISAI) + Kake***] allows to perform the ***Chaotic Forms***, that are based on a simple o complex variation of the (***SSAI*** or ***ISAI*** or both).
Then ***Chaotic Form belong to the Lever Group with the application of special grips (SSAI) that allows to apply forces in different (non traditional) direction or using the (ISAI) in non classical way,*** producing the chaotic non rational throwing for our brain used to know classic Go Kyo performance. Throwing techniques produced in such way are normally called new, and it is very difficult to face them.

In the following figures there are shown ***Innovative Techniques*** (some of them named by Roy Inman) belonging to both group Couple and Lever, with many variation on UCHI MATA showing the stereotyped Body movement connecting many different kind of grips that allow only small directional variation (***Innovation***).
At the end there are shown some "***Chaotic Form***", in which is easy to see the original use of both ***SSAI*** and ***ISAI***

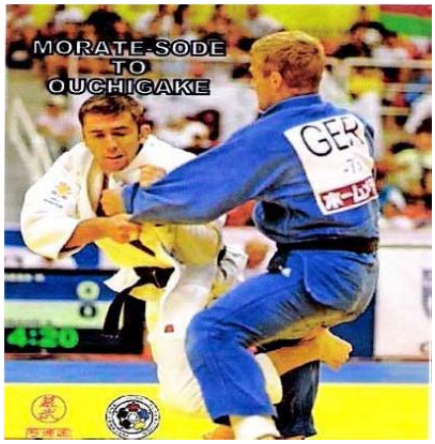


Diag 1 Summary of the Kuzushi Tsukuri Action Invariants connected to Kake phases and Classic or Innovative and Chaotic Form of throwing techniques

Fig 93-98 Innovative Throws (Lever group)

World Championships Seniors+Open - CLOSE

Fig. 98-116 Innovative Throws (Couple of forces Group)



Morate tobe komi makikomi

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Fig.117-150 Innovative Throws (Couple group)
Uchi Mata = same body action (Couple tool), low variation in direction forces, different contact points (grips)

SOTO TOBI-KOMI-UCHIMATA

(MIDDLE LAPEL) MORATE UCHIMATA

Soto Kata uchimata

One hand tobe uchimata

IPPON SEO NAGE UCHIMATA

-63kg

ZDF

QINGDAO 2009

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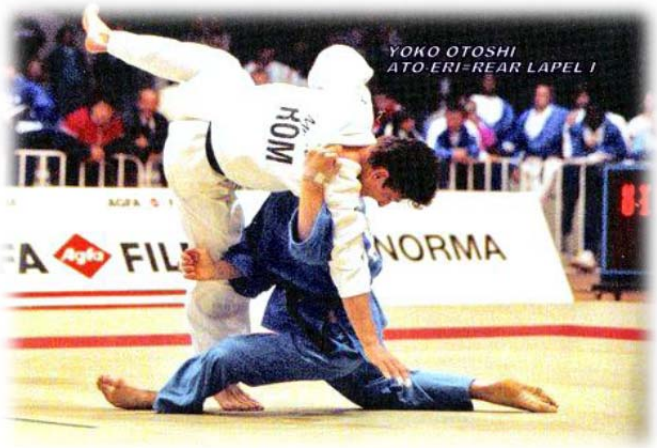
Morate tobe komi makikomi

SODE UCHIMATA-MAKIKOMI

Morate sode Uchimata

Fig 151- 176 “Chaotic Form” of throwing technique <u>only</u> Lever Group



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WAIST GRIPJIKOKU

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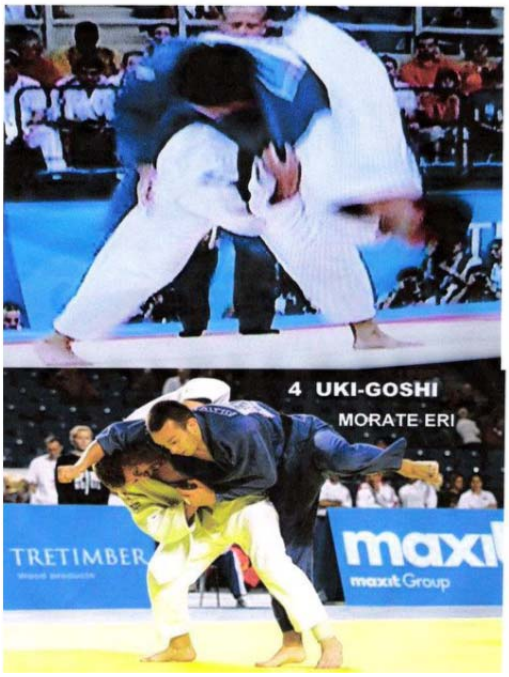

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8 Final remarks on Kumi Kata and Throws in High Level Competition

Now it is possible to resume some basic concepts evolved during this work, not only about function of superior kinetic chains, but about athletes' relative positions, Innovative and Chaotic Form of throws and "style" in high level judo competition. Obviously grips are tools with many roles:

1) Connecting role: at first they connect the two athletes in a one system: the Couple of Athletes System.
2) Driving role: they by the push/pull activity let drive the opponent in a potential favorable position.
3) Stimulating role: they by opportune push/pull actions try to produce good opportunities by previewed reactions
4) Shortening role : they by right actions shorten the distance between Athletes letting useful tsukuri positioning
5) Alerting role: they can be used to receive from the adversary body's movements alert about his attack action
6) Advising role: they can also receive information from the adversary's body about his movements
7) Mastering role : they master the distance into the Couple of Athletes system
8) Slowing role : they are able with the body weight (Japanese tool) or with the curled body's position (Russian Tool) to slow down the opponents' speed movement
9) Creating role : they can create Innovative or Chaotic form of throws transferring forces in nontraditional or non rational directions by SSAI (Superior Specific Action Invariant)
10) Active role: to transfer to the competitor's body an impulse to realize throwing techniques by SSAI (Superior Specific Action Invariant).
11) Passive role: to stop the impetus and the movement of the competitor during his throwing technique.

From that it is possible to give answer to the "funny eternal" question "Which is the best grip?"
In sense of "most effective"; generally speaking, as well known, the grips are the key to effective tachi waza, and every judoka has his preferred method of gripping in order to bring off his favorite throws. Then grips are question, among other things, of: judo knowledge, taste, skill, coordinative capability, and also of relative body dimensions between athletes. Considering all vantages and drawbacks for each kind of grips in term of Biomechanics, the basic ki hon kumi kata represents the most flexible and effective one's.
Our study singlet out the mistake to consider "only" the arm position as grips, showing the useful way to consider the whole position of opponents' bodies in the Couple System grouped in the "Competition Invariants".
In this correct optics, superior kinetic chain masters the distance between athletes, and more interesting, performing SSAI, they are responsible both of Innovation and Chaotic Forms in competitive throwing. In the text it is also analyzed the role of grips in high level competition; whatever the judo situation, whether it is the contest: Word Championship, Olympic Games, etc. the most important evolution in time from the old time to modern games is the variation (shortening) of an extremely important element: the attack distance, or the maneuver space between Athletes into the Couple System that is connected both to the hidden concept of "**Breaking Symmetry**", and to "**Attack Speed**".
Already Japanese Master of Ju Jitsu made specialized studies about distance (correctly interval between fighters) classifying such intervals in three distances:

1. ***to ma*** (big distance);
2. ***chu ma*** (medium distance) and
3. ***chika ma*** (short distance) for fighting.

In judo as well known and analyzed, there are four situations that can be identified not only as interval time during the competition evolution but also as attack space separating the opponents and subsequently by kind of grips that fighters can apply.

I. Athletes separate in no grip situations.
II. One handed grip.
III. Classic two handed grips.
IV. Curled up grips.

These situations are particular moments of the most rational approach referring to "Competition Invariants". The first situation today, with the last refereeing rules, is the area specialized of grips fight. Grip fighting, defined in previously as "arms wrestling" is a wide field of deep study among National Federation, but in high level competitions it is also, more often, the most boring part ones.
Dr. Kano underlined the concept of "Ju" in the use of the opponent's force, and in the text it is shown a more subtle way to overcome this boring phase with the application in a more general meaning of "Sen No Sen" concept.
This special way is, often, applied to this specific situation as very effective and useful tool by some Korean champions.
Competitive Invariants, linked to pace of Athletes Couple System are directly related to Throwing techniques and consequently to Superior Kinetic Chains by SSAI (Superior Specific Action Invariants) and Inferior Kinetic Chains by ISAI (Inferior Specific Action Invariants).
Studying grips and form of throws we are able to understand both: the Innovative and Chaotic Form of Throws genesis, which very often it is possible to see in High Level Competitions.
In fact, as already demonstrated Innovative throws flow from Couple and Lever groups instead Chaotic Forms flow from Lever only.
The first ones by changing arms (grips) position and use of SSAI, and consequently changing throwing forces direction maintaining the same body action movement.
The second ones by changing both SSAI and ISAI applications creating no "Rational" outcome of the traditional Kodokan throws.
Theoretically speaking the first ones are kuzure (Variations) of Kodokan techniques, maintaining the same visual shape with slightly different outcome.
The second ones are completely different applications of SSAI or ISAI with "Irrational" shape and new solutions relatively to Kodokan form of throws.
Few people understood the last subtle work produced by Kodokan and by Toshiro Daigo, in his book : Kodokan Judo Throwing Techniques. "… ***Recent development in competition…have seen an increase in the number of form of Nage Waza, leading to often confusing interpretation of the techniques' name. The purpose of this book, therefore, is to provide a comprehensive and correct classification of Nage Waza…"***.
Kodokan Waza Research Institute enlarged the **40** original Kano's Go Kyo throwing techniques, to **67** new Go Kyo, but, considering the variations (Kuzure) the overall numbers of throws considered by Kodokan is **152**!
What this means? That Kodokan Waza Research Institute considered the **40** or **67** throws as ***basic models*** under the Kano's ***Five Principle*** of classification and with the introduction of kuzure put under the same principles and name also the ***Innovative Forms.*** However this tentative shows the limit of Kano's Classification, in fact, more often, ***Chaotic Forms*** can't be classified at all under the same ***Five Principles*** with the ***same names***; instead the Biomechanical classification with ***Two Basic Principles*** only, shows us his general validity, because ***Chaotic Forms*** are easily classified under the Lever Group techniques, as shown in the previous paragraphs.
These considerations derive by a deep Match Analysis study, which is linked to the fighting styles of major champions of every country. The major outcome of these evaluations is a clear message about competition***: Sport Judo derives from the original Judo Kodokan, educational system organized by Dr. Kano, that the part called Shiai, was utilized for competitions. Today with his worldwide expansion and continuous evolution, Sport Judo became wider than original Judo***

Kodokan part utilized, in term of dynamic interaction, and in this optics Sport Judo can be viewed as Shiai enlargement and evolution.

By Match Analysis it is easy to understand if a country has an original competitive style or not, based on some recurrences: grips, Competition invariant applied, kind of solutions applied in specific situations, preferred pace of competitions, kind of throws, etc..

Every evolved Country shows its own competitive style, which more often is still a blend of two major styles contributions: Traditional Kodokan and Sambo related, in term of throws.

Often it is important to remember that both Innovative and Chaotic forms depend from gripping variations, and then the outcome of this variation applied to a classical throw can produce either Innovative or Chaotic Form. In this view, Judo style could be connected to gripping style.

Normally Japanese fighters have Judo very calm, very dynamic, and very efficient.

They usually are able to utilize every opponent mistake and capitalize; they tend to focus more on the standing competition, while being extra solid on defence on the ground.

They tend to be well rounded, in all competition phase and their style could be really named “high traditional”: very balanced, always quiet, clear headed, and essentially mistake free.

You couldn’t see unorthodox or innovative techniques or Chaotic form in their arsenal, just incredibly good fundamentals at every level.

However, in their preparation, they have an answer for pretty much anything opponents use against them, rarely they are get in trouble, and more often they find a solution at every strange attack suffered.

Dutch Athletes are often dominant in the heavyweight divisions, very solid and strong Judoka, very powerful. Pretty much standard grip and “go” types, with good knowledge in Tachi waza and Ne waza. German Athletes apply today more often non standard grip with many innovative form of throwing, well accustomed to Ne waza with strong physical preparation..

Old Russian (Soviet Union) Judo was strictly linked to Sambo style and also to Free and Greco-Roman wrestling Styles, very unorthodox grips and throws. A little more balanced, and again more towards the heavier scale.

Today this style is heritage of Georgian, Kazakhstan, Azerbaijan Mongolian and others East Countries.

Fig 177-180 High Unorthodox technique Chaotic Form Mongolian vs Russian Athlete

Modern Russian Style, is more standard connected to Kodokan style, with deep roots always into the Sambo style approach (not so high shifting speed and a lot of strength in throwing actions), the modern Russian Style could be well described as “Strong Classic” and effective.
British Athletes, very often, are Ne Waza oriented, usually very fast and skilled in their attacks, utilizing a lot of Innovative throwing techniques and chains.
Old French style was a very classic one’s, but today it is more mixed with innovative throws.
France has, more often, good heavyweights, well stand-up.
French athletes are good gripping and all around fighters. They have good Ne Waza defence and knowledge, and high standard skills, and their federation is one of the best organized in EU, with very good teaching and didactic structures and tools.
Central South America/Caribbean: usually show influence of Brazilian Ju Jitsu (BJJ), with a good mat work. Their Champions are well represented throughout all weight divisions; usually they utilize not a lot of innovative techniques, but are solid Judokas.
United States Athletes are more often eclectic, representing all ranges of skill.
Chinese athletes show high level of physical preparation and classical skill in judo.
Korean champions show a very eclectic fast style based more often on “Innovative Form” with some preferences for “Chaotic Form” of Throws. Every place has his style, more often wider ranging from traditional to Innovative. This short description is very general and not well suited to all situations and, of course, it is possible to find a lot of variances and nuances. Furthermore, the current increase in number and frequency of high level championships tends to homogenise the Countries’ style differences.
The only exception among all word countries is Japan, which champions play a very high traditional judo without any pollution of other styles.
What are the inner meanings of these evaluations? The two main outcome of the previous speech are: 1) Sport Judo played at world level by 199 Countries, born in Japan is today, considering the different contributions, a son of world. 2) From the intellective point of view, a complex Sport needs clever athletes and coaches, and with the different world contributions Sport Judo grows in complexity and needs/produces new and cleverer Champions and Coaches that must face and overcome this complexity. But which is the more effective style in the world, without mistake the Japanese one’s based on timing and traditional techniques perfect application, followed by Korean and Russian. .

Fig. 181 Classic Throw

In the Three following appendices there are shown, some different (Judo/ gripping) styles; ranging from Eclectic Korean, Strong Classic modern Russian and High Traditional Japanese. In the Fourth Appendix the four Top Nation of the EJU countries in EJU area are showed during the period 2006-2010, and these nations ranked at world level in the same period. In the Five Appendix is analyzed also the not well understood women contribution to Sport Judo, with their indicative preferred throws

Fig 182 Innovative Variation

Fig 183 Chaotic Form

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Appendix I

Korean Champions gripping style: Eclectic

The gripping style of Modern Korean champions is very interesting, normally they masters sufficiently well the traditional grip and also the crossed grips, but their preparation is very far from traditional techniques they are substantially pragmatic applying whatever movement useful to throw the opponent in valuable way.

Athletes are very strong in arms, legs, and lover back essentially, the technical knowledge is mean: three, four throws on the two sides with the same mastery, few combinations on two techniques connected.

The main weapons in gripping application for throwing are related to: two lapels, two sleeves, or two hands on the same arm, and two hands on the same lapel, very often connected to with a very low Tai Otoshi, or Suwari Seoi, due to their high flexibility, and other innovative throws applied with fast and strong decision.

In the following figures there shown three examples of Korean Eclectic Style

Fig I, 1 Totally lateralized Seoi with two hands on arm Innovate with diving

Fig I,2 Very low Suwari Seoi grips on two sleeves Innovative coming up in rotation

Fig I,3 Jumping Tai Otoshi grips two hands on one arm Innovation in Rotation

Appendix II

Present Day Russian Champions gripping style: Strong Classic

The gripping style of Russian champions today is very different from old time, the new generations and the new rules help Russian Champions to leave the Sambo mixed style.

Today Russian Athletes masters very well classic judo, grips are more often lapel and sleeve with some tendency to one sided on opponents' back belt or, sometime, crossed.

Throwing techniques are more often classic (Kodokan version) but the background of physical preparation is already connected to Sambo legacy. More often counter are leg grabs, Kodokan or Innovative. The shifting velocity is not high and the whole impression is that every technique is applied with high strength and low speed.

Athletes are very strong and lack, a bit, in some arms and legs flexibility, the technical knowledge is mean: two, three throws one sided, some combinations not more than two techniques connected.

The main weapon in gripping application for throwing is related to strong classical grips, sometime crossed, and connected to the slowing down of the shifting velocity with strength and with not fast attack speed.

In the following figures there shown four examples of Russian Strong Classic Style:

Fig II,1 Classical Uchi Mata, with classical grips, with an horizontal rotational component

Fig.II,2 Lateralized Seoi, with double grip to one lapel , Innovation in diagonal kuzushi

Fig.II, 3 Strong Hiza Guruma (Daigo), with back shoulder grip, Innovation in Rotation

FigII,4 Powerful Kuchiki Taoshi applied as counter, innovation in diving

Appendix III

Japanese Champions gripping style:
High Traditional

The gripping style of Modern Japanese champions today is very flexible, the growing of Judoistic capabilities of the opponents but also the different styles of fight (non classical grips) make Japanese Champions able to face in high level competition all the world with a very high flexibility. If the opponent is japans there is a greater tendency for the two opponents to get a firm grip on each other, rather than for fighting to grab part of the opponent's Judo wear.

Today Japanese Athletes master very well different kind of grips, many in Henka Yotsu , but technical throwing perfection, and will to win is always at top in modern Japanese Champions, Today athletes are able to change pace of fight and Competition Invariant without suffer in lack of technical ability Japanese Champions are able to face different kind of grips with the same high standard results; from the classic ones to the one-handed fight in Henka Yotsu.

Throwing techniques are more always classics with the capability to apply either Innovative or Chaotic Form without any problem. Normally they are able to apply different shifting velocity with different opponents and the whole impression is that every throw is timing applied with classical clarity.

Athletes are strong, flexible, and always in judo shape, the technical knowledge is: three, four throws on the two sides, not the same techniques but two complementary techniques, each technique for each side, few combination more o less two throws connected, often they don't like groundwork so much. There are not main weapon in gripping application, but high adaptation capability to different Competition Invariants. Throwing techniques are related to classical grips, with high timing and effectiveness.

In the following Sequences there are shown five examples of Japanese Traditional Style:

Fig III,1 Classical timing example of Ashi Harai with traditional grips

Fig.III,2 Classical Action of Ko Uchi Makikomi, traditional grips

Fig.III,3 Classical Harai Goshi, with traditional grips

Fig III,4 Classical O Soto Otoshi with innovative grips

Fig III, 5 Traditional Uchi Mata attack

Appendix IV

EJU and IJF Top Nations Statistics

Source: Hans van Hessen www.judoinside.com

European Countries Top Nations

Statistics 2006-2010

Ranking for all European Events 2006-2010 (sorted on #gold)

- World Cups in Europe
- Super World Cups
- European U17, U20, U23, senior Championships

We've defined Russia, France, Netherlands, and Germany as top nations

Nations	1	2	3	Grand Total
RUS	**137**	**110**	**207**	**454**
FRA	**91**	**89**	**147**	**327**
NED	**54**	**51**	**100**	**205**
GER	**52**	**73**	**140**	**265**
GEO	50	45	98	193
HUN	39	36	59	134
UKR	38	58	117	213
SLO	32	25	41	98
ESP	29	32	54	115
AZE	27	23	61	111
ITA	24	31	58	113
ROU	23	22	51	96
GBR	22	17	63	102
POL	20	28	72	120
POR	20	13	37	70
BLR	19	34	42	95
TUR	14	18	34	66
CZE	13	7	15	35
BEL	12	11	42	65
GRE	11	10	24	45
ISR	11	11	23	45

AUT	10	15	34	59
EST	8	9	16	33
LAT	6	6	16	28
ARM	5	9	13	27
SUI	4	6	15	25
SWE	3	1	6	10
LTU	3	5	10	18
LUX	3		1	4
BUL	3	4	9	16
CRO	3	3	9	15
NOR	2			2
MDA	2	1	6	9
ALB	2	1	2	5
FIN	1	8	11	20
SER	1	4	3	8
MNE		1	3	4
IRL		1	1	2
BIH		1	3	4
SCG			1	1
DEN			1	1
SVK		4	6	10
Grand Total	794	823	1651	3268

Source: Hans van Hessen

World Countries Top Nations

Statistics 2006-2010

Ranking for IJF events 2006-2010 (sorted on #gold), <u>for all countries</u>

Nations	1	2	3	Grand Total
JPN	165	101	157	423
KOR	61	46	80	187
RUS	60	57	108	225
FRA	59	57	96	212
CHN	43	17	40	100
MGL	26	23	63	112
NED	21	40	55	116
BRA	19	24	46	89
GER	18	24	78	120
UKR	12	19	42	73
UZB	11	17	29	57
GEO	10	11	16	37
SLO	9	10	21	40
AUS	9	7	16	32
CUB	7	17	25	49
EGY	7	5	15	27
BEL	7	9	22	38
AUT	7	7	14	28
KAZ	6	7	19	32
ROU	6	6	15	27
USA	6	6	17	29
AZE	6	8	23	37
CAN	6	7	13	26
POL	5	6	21	32
HUN	5	14	40	59
POR	5	10	8	23

GRE	5	3	6	14
ITA	4	12	18	34
ESP	4	16	28	48
ARM	4	1	4	9
SUI	3	1	6	10
BLR	3	7	2	12
GBR	3	8	15	26
TUR	2	2	11	15
CZE	2	1	7	10
KOS	2			2
FIN	1	1	2	4
COL	1		1	2
TUN	1	5	5	11
MON	1		1	2
CRO	1		4	5
IRL	1			1
TJK	1		3	4
EST	1		4	5
PER	1	1		2
MDA	1		1	2
ALG	1	4	7	12
BIH	1			1
PRK	1	4	11	16
ISR	1	5	6	12

Source: Hans van Hessen

Appendix V

Women’s Grips Biomechanics and Statistics

Women's grips Biomechanics

It is well known that muscular strength between men and women is different; normally women have the 80%-85% of men's muscular strength in the legs and around the 60-70% in harms and grips.

It is common knowledge that with strength training women's muscular force of harms could increase at near level of same weight men 85-90%.

This information is not validated by scientific studies.

About grip strength and gender difference among men and untrained and well trained women, an interesting German study involving also well trained female Judo athletes, performed by D.Leyk and co workers in 2006 give us interesting results about real grip strength in women.

In the following figures there are some results from this study.

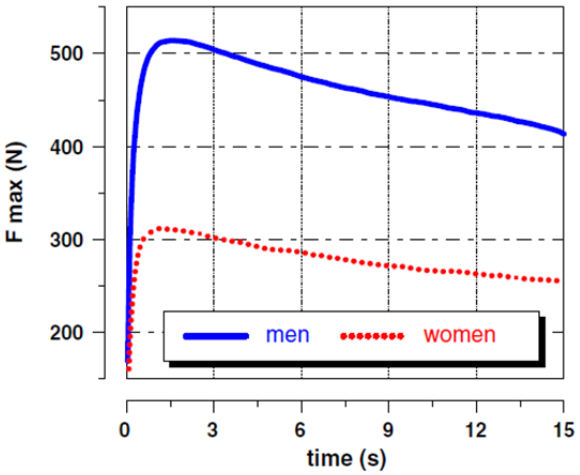

Fig V.1 Evolution in time of grip force in man and women

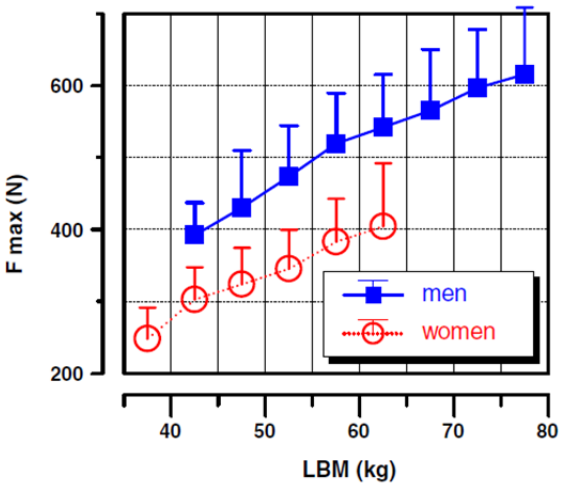

Fig V,2 Maximum hand grip Force of different Lean Body mass

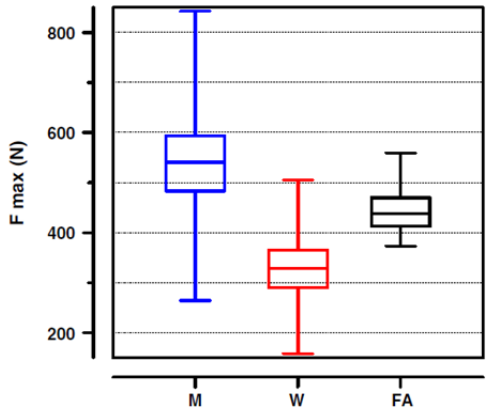

Fig.V, 3. Maximum hand grip force among non trained men, women and female elite Judo athletes

Then female elite athletes, also after training have a lower hand grip strength than male untrained group. This situation lead to a different approach to competition; a Thesis performed by Paulo Henrique Junqueira Hudson in 2007 on the world championship of the same year shows the following results:

G. Técnicas com ippons	Masculino	Feminino
Ashi-waza	24,1	11,8
Koshi-waza	3,4	0
Te-waza*	**55,2**	**17,6**
Sutemi-waza	13,8	11,8
Katame-waza**	**3,4**	**58,8**

Notas: * Diferença estatisticamente significativa masculino *vs* feminino (χ^2 = 8,895; p = 0,003)
** Diferença estatisticamente significativa masculino *vs* feminino (χ^2 = 7,364; p = 0,007)

Fig V,4 Example of difference in techniques application between Male and Female (%)

These results are instantly connected to the previous ones' women apply the same percentage of (Ashi) legs techniques and (Sutemi) Sacrifices, but very few (Te) hand techniques and in contrary are more consistent and effective in (Ne Waza) groundwork.
Another big difference in women constitution is their greater joints' laxity and flexibility this is the reason that it is possible to see, high body's turn both during throwing actions and in Ne Waza, or long resistance with extreme angles in Kansetsu Waza application.
Also in attack rhythm there is difference Sterkowicz note in Olympic games of 1996 that " *Another characteristics feature of female athletes was the lower intensity of action during the attack and especially the frequency of penalties than in men who were better able to use the time of the fight."* Generally speaking women's grips application is more standard than men in percentage (Classic Ki Hon Kumi Kata left or right), but the increase of Russian gripping is also present form Nation to Nation.

More often application of throws is Innovative or Classic, very few Chaotic Forms are seen in women competition, but the percentage of Innovative variations is higher due to the body's flexibility of athletes.
Connection Tachi Waza – Ne Waza, for Koshi Waza is very often linked to the application of Makikomi variation of throwing techniques as it shown in one of the following figures.

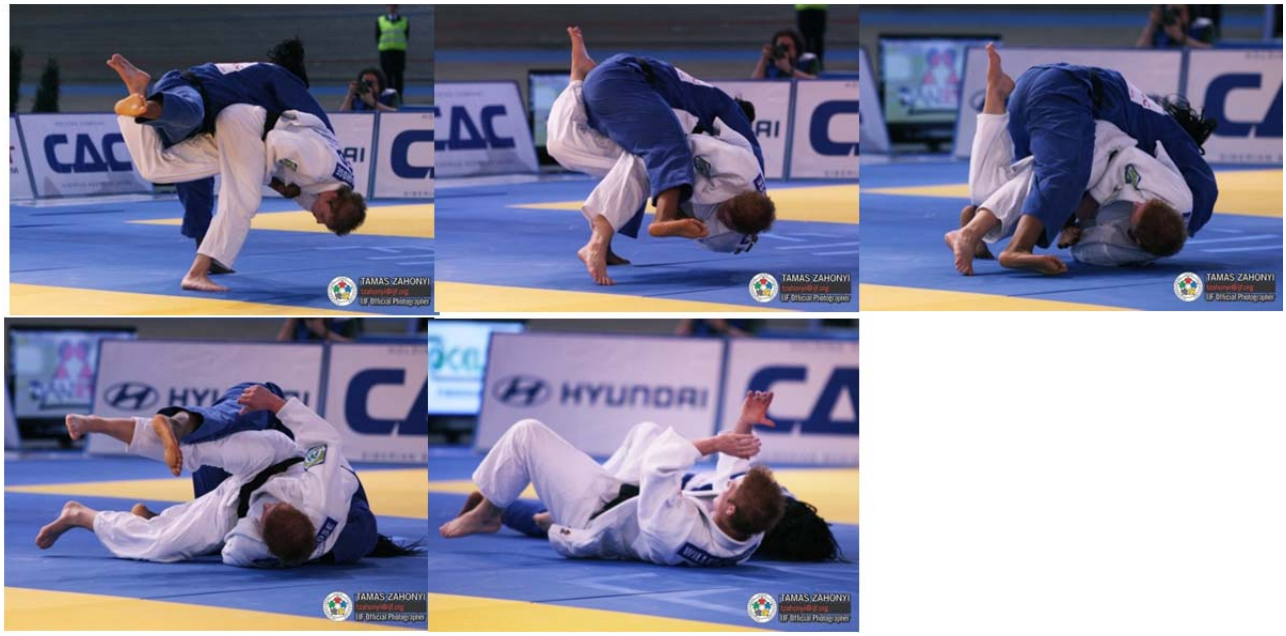

Fig V,5 High trunk flexibility in Innovative Uchi Mata

Fig V,6 High hip flexibility in Innovative Uchi Mata

Fig V,5 Innovative Makikomi

Normally, in women competitions, grip fight is less strength based, attack velocity is no as explosive as in men competition, and generally pace of contest is slower and it is possible to note that almost all female judo contests are smoothed confronted to male judo.
It is interesting to note that the poor presence of Chaotic Form of techniques in women games is directly connected to the natural and relative lack of strength both in hands and legs of female athlete's body structure. Then women's judo remains more connected to Kodokan Judo as for grips preference, as for the form of throwing techniques applied (Classic or Innovative).
Now can be asked a common idea in West countries: Sport Judo is a male or female?
In the previous ranking based on gold medals the ranking is **1) RUS; 2) FRA; 3) NED; 4)GER.**
However considering the grand total the result is **1) RUS; 2) FRA; 3) GER; 4) UKR.**
But what is the importance of role of women judo in EJU and IJF?
If we are looking for the top four, highlighting the women role only, changes are introduced in EJU and bigger in the IJF previous rankings.

Women TOP FOUR EJU NATIONS FOR EJU COMPETITIONS		
NATION	GOLD	GRAN TOTAL
FRA	**61**	**199**
RUS	**45**	**193**
NED	**38**	**74**
GER	**32**	**85**

Women TOP FOUR IJF NATIONS FOR ALL COMPETITIONS		
NATION	GOLD	GRAN TOTAL
JAP	**102**	**245**
FRA	**40**	**144**
CHN	**36**	**88**
KOR	**16**	**75**

If we see the male contribution to Sport Judo, all previous ranking are speedy and totally changed, both in EJU and IJF, showing the big weight of women in the final ranking.
As it is possible to see in the next two tables

Men TOP FOUR EJU NATIONS FOR EJU COMPETITIONS		
NATION	GOLD	GRAN TOTAL
RUS	**92**	**261**
GEO	**50**	**189**
FRA	**30**	**128**
AZE	**24**	**85**

Men TOP FOUR IJF NATIONS FOR ALL COMPETITIONS		
NATION	GOLD	GRAN TOTAL
JAP	**57**	**167**
RUS	**43**	**154**
KOR	**43**	**106**
FRA	**19**	**66**

Then Sport Judo seems not a male prerogative, women play in it a very important role both in EJU and IJF.
The participation of women to Sport is a cultural problem in many countries, but we must also remember that, if the basic physical principles of throwing are the same for men and women athletes; Female Judo is totally different on the basis of physical and anthropometric differences, strength differences both in leg and more in arms and hands, or psychological differences and so on. All this means different way to think training, to approach technical preparation, or to choose the right class of applicable throwing techniques.
From the previous considerations, generally speaking about useful and effective throwing techniques, the question is obviously connected to athletes' body strength and morphology, then to their weight and preferred pace of competition, after to the physical skill and capability both of athletes and opponents. But in general way women judo athletes prefer, Ashi Waza, Sutemi Waza and some Koshi waza in Makikomi evolution, all applied both in Classic and Innovative form.
In Biomechanical terms they prefer specifically Couple Techniques most of trunk leg group, Physical Lever Techniques with minimum arm applied with Makikomi final closure, and Maximum Arm Techniques (Sutemi) most applied with body weight and legs , few with a big contribution of arms.
Few Chaotic Form, are seen because, normally, they need to be applied by use of strong arms contribution.
For their flexibility they utilize a lot Ne Waza with preference for Osae Waza.
Till now at EJU level three of the Four Top Nations give the just importance at Women Judo.
At world level only: Japan, France, China and Korea seem to have understood this lesson in right way.

Ranking for all European Events 2006-2010 by gender (sorted on #gold)

- World Cups in Europe
- Super World Cups
- European U17, U20, U23, senior Championships

	1		1 Total	2		2 Total	3		3 Total	Grand Total
Geo	1	2		1	2		1	2		
RUS	92	45	137	55	55	110	114	93	207	454
FRA	30	61	91	36	53	89	62	85	147	327
NED	16	38	54	20	31	51	38	62	100	205
GER	20	32	52	23	50	73	42	98	140	265
GEO	50		50	44	1	45	95	3	98	193
HUN	11	28	39	17	19	36	29	30	59	134
UKR	19	19	38	30	28	58	61	56	117	213
SLO	7	25	32	8	17	25	9	32	41	98
ESP	7	22	29	11	21	32	17	37	54	115
AZE	24	3	27	19	4	23	42	19	61	111
ITA	11	13	24	17	14	31	31	27	58	113
ROU	3	20	23	2	20	22	11	40	51	96
GBR	9	13	22	7	10	17	23	40	63	102
POL	12	8	20	12	16	28	36	36	72	120
POR	6	14	20	7	6	13	19	18	37	70
BLR	18	1	19	22	12	34	23	19	42	95
TUR	3	11	14	6	12	18	9	25	34	66
CZE	10	3	13	5	2	7	11	4	15	35
BEL	2	10	12	7	4	11	15	27	42	65
GRE	9	2	11	9	1	10	21	3	24	45
ISR	6	5	11	5	6	11	15	8	23	45
AUT	4	6	10	5	10	15	15	19	34	59
EST	8		8	9		9	16		16	33
LAT	6		6	6		6	15	1	16	28
ARM	5		5	7	2	9	13		13	27

SUI	2	2	4	5	1	6	7	8	15	25
SWE	2	1	3		1	1	5	1	6	10
LTU	2	1	3	5		5	7	3	10	18
LUX		3	3					1	1	4
BUL	2	1	3	1	3	4	5	4	9	16
CRO		3	3		3	3	4	5	9	15
NOR	1	1	2							2
MDA	2		2	1		1	5	1	6	9
ALB		1	1		1	1		2	2	4
FIN	1		1	1	7	8	6	5	11	20
KOS		1	1							1
SER		1	1	3	1	4	1	2	3	8
MNE				1		1	2	1	3	4
IRL					1	1		1	1	2
BIH					1	1	2	1	3	4
SCG							1		1	1
DEN								1	1	1
SVK				4		4	6		6	10
Grand Total	400	394	794	410	413	823	833	818	1651	3268

Source Hans van Hessen

Ranking for all World level events by gender (sorted on #gold total) 2006-2010

World Cups, Masters, Grand Prix, Grand Slams, Wchs, Wchs U20, Olympic Games

For all countries

	1		1 Total	2		2 Total	3		3 Total	Grand Total
geo	men	women		men	women		men	women		
JPN	57	102	159	44	55	99	66	88	154	412
KOR	43	16	59	25	19	44	38	40	78	181
FRA	19	40	59	8	49	57	39	55	94	210
RUS	43	12	55	40	17	57	71	32	103	215
CHN	5	37	42	5	12	17	6	33	39	98
MGL	17	9	26	15	8	23	37	26	63	112
NED	11	10	21	19	21	40	25	30	55	116
BRA	12	6	18	14	8	22	28	16	44	84
GER	9	9	18	9	15	24	26	47	73	115
UKR	8	4	12	10	9	19	21	20	41	72
UZB	11		11	13	3	16	29		29	56
GEO	10		10	10		10	15		15	35
SLO	1	8	9	4	6	10	2	19	21	40
AUS	4	5	9	2	5	7	9	7	16	32
CUB		7	7	9	8	17	8	17	25	49
EGY	7		7	5		5	14	1	15	27
BEL	4	3	7	5	2	7	11	10	21	35
AUT	3	4	7	4	3	7	6	6	12	26
KAZ	6		6	6	1	7	15	3	18	31
ROU	1	5	6	1	4	5	3	12	15	26
USA		6	6	2	4	6	9	8	17	29
AZE	6		6	6		6	18	5	23	35
CAN	2	4	6	4	3	7	9	4	13	26
POL	4	1	5	5	1	6	10	11	21	32

HUN	1	4	5	6	7	13	21	19	40	58
POR	1	4	5	1	9	10	3	5	8	23
GRE	4	1	5	3		3	2	3	5	13
ESP	2	2	4	4	12	16	7	21	28	48
ARM	4		4	1		1	4		4	9
BLR	3		3	7		7	2		2	12
SUI	1	2	3	1		1	2	4	6	10
ITA	2	1	3	6	5	11	12	5	17	31
GBR	2	1	3	4	4	8	8	7	15	26
CZE	2		2	1		1	5	2	7	10
TUR	1	1	2		2	2	1	9	10	14
KOS		2	2							2
ALG		1	1	2	2	4	3	4	7	12
COL		1	1					1	1	2
TUN	1		1		5	5	1	4	5	11
MON	1		1					1	1	2
CRO	1		1				1	2	3	4
EST	1		1				4		4	5
TJK	1		1				3		3	4
FIN		1	1		1	1		2	2	4
PER	1		1	1		1				2
IRL		1	1							1
PRK		1	1	1	2	3	4	6	10	14
MDA	1		1				1		1	2
BIH		1	1							1
ISR	1		1	2	3	5	2	4	6	12
IRI				1		1	4		4	5
SVK							2		2	2
NCL					1	1		1	1	2
NZL				3	3	6	5	3	8	14
LUX					2	2				2
AND				1		1				1
CHI								1	1	1

BUL						1	1	2	2
VIE							1	1	1
FIJ						1	2	3	3
SWE						4		4	4
KGZ						1		1	1
TPE						1	1	2	2
PUR							1	1	1
MEX							1	1	1
ARG						2	4	6	6
MNE						1		1	1
IND							1	1	1
VEN				1	1				1
LAT				2	2	1		1	3
MAR						1		1	1
LTU				1	1	2	1	3	4
Grand Total	314	312	626	314	311	625	627	607	1234	2485

Source: Hans van Hessen

Indicative Preferred Women Throws Biomechanics: Couple of Forces applied by Trunk and Legs. (Innovative Forms)

PHOTO
SABAU GABRIELA

ALG
KOR

Indicative Preferred Women Throws Biomechanics: Physical Lever (medium arm). (Innovative Forms)

Indicative Preferred Women Throws Biomechanics: Physical Lever applied with Makikomi. (Innovative Forms)

Indicative Preferred Women Throws Biomechanics: Physical Lever: maximum arm (Innovative Forms) (sutemi),

Women Grip fighting

Women Throws Biomechanics: Few Chaotic Forms

Fig V,7 Women Innovative Form

Fig. V,8 Women Innovative Form

Fig.V,9 Men Chaotic Form

Fig.V,10 Men Innovative Form

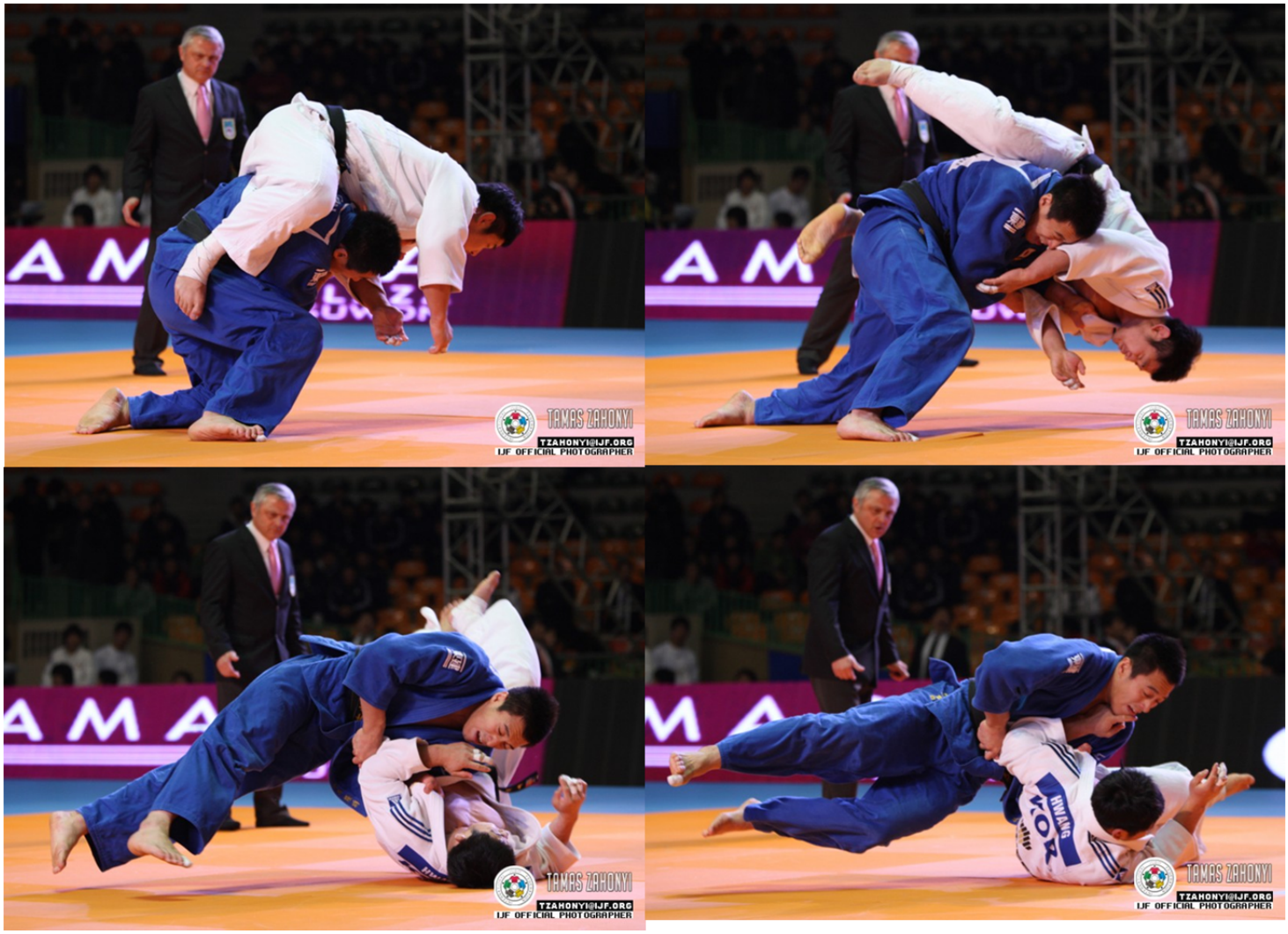

Fig.V,11-15 Men Classic Form

This is the first book who analyzes Kumi Kata (gripping methods) deeply and in every nuances of their connection, with throws; starting from Dojo till to High level competition.
The book is divided in three parts Biomechanics and related researches carried out in the world, Kumi Kata in Standard Judo , and Kumi Kata and Throws in Advanced Judo.
Biomechanics part is related to the understanding of push/pull action, connected to the extension to whole body action.
Judo part presents a review of the most well known concepts applied to Kumi Kata from the teaching and coaching point of view, and a “standard” rationalization of Kumi Kata phases in competition, like no grips, grips fighting, stabilized grips, etc.
It is shown to coaches the right way to understand their influence in competition, analyzing the whole system Couple of Athletes.
Kind of grips, gripping fight, methods to avoid them and their application in competition from the well known standard to the most subtle ones.
The Judo advanced part presents a deeper analysis of real Kuzushi meaning and application Kumi Kata concept, new way to avoid grips fighting with the “Ju” approach to competition, and analyzes the Throwing techniques evolution in high level competition, classifying for the first time these techniques in “Classic”, “Innovative” and Chaotic Form”, thing which shows that Sport Judo born in Japan is today son of World.
With a careful biomechanical analysis, it is singlet out how these techniques born and what are the tools applied in high level competition.
There is also performed both a deep analysis on changes evolved in Sport Judo in the last five years and a study of Countries Judo Styles connected to their Champions; also a careful study of competition evolution, point of interest for coaches and athletes.
These are results flowing by Judo "Match Analysis" applications. Five appendices analyze the different fighting styles of the three Judo Top Nations, the statistics of medals during the last five years both for EJU championship and at World level. The last appendix is an exploration of the misunderstood women contribution to Sport Judo, finding also the class of preferred throwing techniques and the special way to apply them.
A fundamental Judo book that could be useful for coaches, athletes, students and for all people who try to understand Judo Sport and the competition inner mechanisms, in his complex reality.

Attilio Sacripanti, Nuclear Physicist (Naples 1947) VI° Dan is author of 125 scientific papers 42 international quotations, 18 books, 8 industrial patents. He wrote, in 1988, the first complete book on Judo Biomechanics, the second edition “Advances in Judo Biomechanics Research” was published in 2010.
Actually he is Commissioner of the Judo Knowledge Commission, Scientific consultant of the Didactic Commission of European Judo Union, Honorary life Member of The Malta Judo Federation.
Senior Prime Researcher at ENEA he was Professor, at University of Rome 'Tor Vergata', with the Chair of Biomechanics of Sports, from 2000 till to 2010. Today is Scientific Tutor and Responsible in the postgraduate Master “Teaching and Coaching Judo”, among EJU, FIJLKAM , and University of Tor Vergata under the behalf of Lazio Council.